THE CLIFTON PARK SYSTEM OF FARMING.

ROBERT H. ELLIOT.

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ROBERT H. ELLIOT, of Clifton Park.

PRESENTED
BY The author.

[ENT. STA. HALL.]

THE CLIFTON PARK SYSTEM OF FARMING

AND

LAYING DOWN LAND TO GRASS.

A GUIDE TO LANDLORDS, TENANTS, AND LAND-LEGISLATORS.

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BY

ROBERT H. ELLIOT,

AUTHOR OF "THE EXPERIENCES OF A PLANTER," "GOLD, SPORT, AND COFFEE PLANTING IN MYSORE," ETC.

Being the Fourth Edition (with notes of Experiences up to November, 1907) of "THE AGRICULTURAL CHANGES REQUIRED BY THESE TIMES."

"The study of grasses would be of great consequence to a northerly and grazing kingdom. The botanist that could improve the sward of the district where he lived would be a useful member of society; TO RAISE A THICK TURF ON A NAKED SOIL WOULD BE WORTH VOLUMES OF SYSTEMATIC KNOWLEDGE; *and he would be the best Commonwealth's man that could occasion the growth of two blades of grass where one alone was seen before."*—White's "Natural History of Selborne."

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"After the rudiments of education and religious instruction, the next step would be with authors of agriculture, Cato, Varro, and Columella, . . . and here will be an occasion of inciting and enabling them hereafter to improve the tillage of their country, *to recover the bad soil, and to remedy the waste that is made of good.*"—*Milton.*

To the Memory

of the late

Mr. Faunce De Laune.

PREFACE

TO THE

First Edition of "Agricultural Changes."

I HAVE dedicated this book to my late really-to-be-lamented friend, Mr. Faunce De Laune of Sharsted Court, Kent, because I, in common with a vast number of landowners and farmers, owe him a great deal of gratitude for having, in his article "On Laying Down Land to Permanent Pasture,"* been the means of calling attention to the once deplorable condition of the British seed trade. This is sufficiently exemplified by a single quotation from the article alluded to, and in which Mr. De Laune says:—"I found that, however careful I was in my orders, and from whatever seed merchant I ordered my seed, the per centage of ryegrass, soft woolly grass, and other bad grasses and weeds, was beyond all belief." My

* *Journal* of Royal Agricultural Society of England. Part I., No. xxxv. 1882.

own experience, I am sorry to say, was the same as that of Mr. De Laune's, and in some cases a botanist I employed could not discover a single plant of some of the more valuable grasses the seeds of which I supposed I had put down, and which, of course, I had paid for. But my friend's article at once aroused the trade and the public, and led to that system of guaranteeing seed which was initiated by Mr. James Hunter, the well-known seed merchant of Chester, whose treatise on permanent pasture has, I may mention in passing, been highly and justly commended by Mr. De Laune. My friend had often been urged by me to bring out a book on the subject of laying down land to grass, and I am given to understand that he had made preparations for the work; but after his death all that could be discovered amongst his papers were some proofs, which were evidently those of his articles in the *Journal* of the Royal Agricultural Society, though a good many passages, one of which I have quoted (*vide* page 23), must have been deleted. The following brief notice of Mr. De Laune will be interesting to his friends, and also, I hope, to many of those who, like myself, have benefited by his work:—

Mr. Faunce De Laune came of an old Kentish family, and one of his ancestors—a naval officer—

was present at the attack on the Spanish Armada in the year 1588. The family suffered much in the civil wars, and one of them was knighted at the Restoration for his loyalty to the Royal cause. My late friend was born in 1843, succeeded his father in 1861, and died in 1891 from an illness contracted when travelling in India. He was a man of many accomplishments and varied interests, much travel in various parts of the world, and was always a most agreeable companion. He was fond of sport, a good man across country, and possessed of all those physical and mental energies which are indispensable to success in most branches of life. Though he wrote and spoke on other subjects, he was chiefly known for the great interest he took in agriculture and fruit-growing, and also for his experiments as regards the cultivation of home-grown tobacco. But, as we have seen, the work of greatest value to the agricultural world was that connected with laying down land to grass. This I followed up in Scotland, both by writing, lecturing, and experimenting on a large scale; and if I have in any degree been the means of improving the mixtures now being used, and diminishing the weeds which the farmers once sowed with their grass seeds, it is entirely owing to the initiative of my late friend, the consequential value of whose work it would,

indeed, be difficult to over-estimate. He was appointed one of the governors of the Royal Agricultural Society of England, and, had he not been so unfortunately cut off, would, no doubt, have contributed still further to the progress of agriculture in Great Britain.

I have much pleasure, in conclusion, in acknowledging my obligations to Mr. James Hunter, who has been kind enough to supply me with the remarks and valuable tables which the reader will find in the Appendices.

ROBERT H. ELLIOT.

Clifton Park, Kelso, Roxburghshire,
October 18*th*, 1898.

PREFACE

TO THE

Second Edition of "Agricultural Changes."

THE first edition of this book was printed for private circulation, and many copies were given away—mostly to people personally unknown to me. From the numerous letters I have received asking for advice, and the many agricultural visitors to the farm from Scotland and England, I am now satisfied that a book on the subject is urgently needed. I therefore publish what I have previously written, and have added an account of our most recent experiences.

I may add that my object throughout has been to show how the farmer can steadily improve his condition and the fertility of the soil, and at the same time diminish his expenditure. I need hardly say that, under the present conditions and future prospects of the labour market, these points must be carried out in order to place our agriculture on a sound footing.

ROBERT H. ELLIOT.

CLIFTON PARK, *November 7th*, 1900.

PREFACE

TO THE

Third Edition of "Agricultural Changes."

SINCE the publication of the second edition much valuable experience has been gained, and, as the second edition of 1,000 copies is nearly exhausted, I beg to offer the present edition to the agricultural world, and this Preface to every Englishman who feels any interest in our national welfare. This book shows how vast sums now spent on imported manures and feeding stuffs may be saved, how crops may be successfully grown on land that has become almost derelict, how the decline of employment in our rural districts may be arrested, and, further, how it may be gradually increased. The proofs of these statements are open to anyone who chooses to visit the Clifton-on-Bowmont farm, which has been visited by many hundreds of practical farmers from many parts of these islands. The valuable confirmatory opinions I have received

have amply compensated me for the time and labour I have expended on this subject. For many years past we have been doing what ought to have been the work of an agricultural department; our correspondence has reached far beyond these islands, and it may be of interest to mention that we have heard on the subject, either directly or indirectly, from India, Chili, Peru, the Argentine Republic, the Antipodes, Canada, and Rhodesia. From the many confirmatory opinions I have received I quote the following from a Roxburghshire tenant farmer, as it illustrates so conclusively the national importance of the work that has been carried to most successful results at Clifton-on-Bowmont. The passage, I may mention, has already appeared in my letter in the *Times*, under the heading of "Agricultural Depression," on October 12, 1904. The tenant farmer alluded to writes as follows:—

"From the short experience I have had on my farm of practising a modification of your system, I am now thoroughly convinced that most of the poor land in this country could be profitably farmed and give more employment to labour than it possibly can do at present. Clifton-on-Bowmont proves beyond question how much can be done to cheapen production and maintain the fertility of the land through natural and scientific methods. Your example should prove a guide and a warning to many who would run to extremes in laying too much land, thought worthless for growing crops, to grass of inferior quality. Such land can never be profitably held in that way. Clifton-on-Bowmont teaches a different lesson, and conclusively proves that much poor land going out of cultivation, and carrying a

poor short stock in consequence, can be successfully cropped by a proper rotation; and that, instead of driving more people off the land to make room for a few sheep, it can be made to give employment to more people, and produce much more and better sheep. This is the first year I have adopted your system as regards cropping, and I am highly pleased with the results so far, as I never had turnips do so well, and the system saves certainly 30 per cent. in labour* and manure. By another year I hope to work much more of my land on your system."

But the system, which is now widely known as the Clifton Park system, will do much more than produce the effects so forcibly pointed out by my correspondent. It will arrest the steady decadence of all British arable soils. For the last thirty years I have had them through my hands on a large scale, from alluvial flats up to thin soil 800 feet above the level of the sea, and find an only too ample confirmation of the general complaint of practical farmers. At the first great meeting of 400 Aberdeenshire farmers, held more than twenty years ago, exhaustion of the soil was declared to be one of the greatest causes of their difficulties. In the course of discussion with ten leading farmers at Clifton-on-Bowmont last year all seemed to agree in thinking that the soil had declined owing to the exhaustion of organic, or vegetable, matter. With the aid of liming, and a freer and freer use

* I have noticed in Chapter VIII. that if labour can be saved on some farms by the introduction of my system, this reduction will be amply made up for by the quantity of labour that will be required when land now occupied by worthless pasture is again brought under the plough.

of artificial manures, the decadence thus caused is steadily continuing. And the farmer expects that foreign competition may be met by ever augmenting bills for purchased fertilizers, which will cause the soil still further to decline in fertility, while the agricultural chemist, aided by the manure merchant, is emptying his pockets, and at the same time enabling the farmer to run out the remaining fertility of the soil. When, some months ago, I told a very old and experienced practical farming friend that I proposed to grow a fine crop of turnips without the aid of any manure he laughed in my face, and evidently thought the assertion the best joke he had heard for some time; yet this has been done, and on land that never has had any farmyard manure, and the previous turnips of which had only received some artificials. With reference to the successful growing of crops without any other manure excepting that of a turf grown on the spot, and consisting of deeply-rooting plants, combined with a full supply of the leguminosæ, the correspondent previously quoted writes as follows:—

"There is one point which always strikes me, as also many others, when visiting Clifton from time to time, and that is the remarkable fact of seeing such crops from year to year [the farm has now been in the proprietor's hands for 17 years] when so much breeding stock is raised and sold off the place, and so little feeding stuff consumed—practically none. I know of no other secondary arable farm in this country farmed on the old

system, and sown down every year with ordinary grass mixtures, that would continue to grow paying crops unless a very great amount of cake-fed manure, or other artificials, were applied to the turnip break every year. Even valuable old pastures quickly degenerate when a breeding stock, or young animals, are kept without extra cake feeding. Looking at these facts, it is all the more remarkable how much your system and scientific seeding has accomplished on poor high land such as Clifton-on-Bowmont. Your wonderful success in growing potatoes also raises the question of how much might be made from that valuable crop through cheap production by natural means, and practically no other expenses than the labour of planting and lifting, in contrast to the regular potato districts, with their high rents and enormous expenditure of artificial and farmyard manure."

High farming on the old lines is no remedy for low prices. For our sole resource in the face of foreign competition we must look to an economy of production which will carry with it, with the smallest possible expenditure on commercial fertilizers, an increasing fertility of soil. These objects have throughout been kept steadily in view, and have been successfully carried out at Clifton-on-Bowmont.

It is remarkable, or perhaps it is not remarkable, that the Board of Agriculture should have not only failed to distribute leaflets on this important subject, but should even have declined to send (as I suggested it should) to the various County Councils notices of the work at Clifton-on-Bowmont, on the ground that for it to do so would be to identify itself with a system—the principles of my system being as old as agricul-

ture, though the method of carrying them out may be new, and, so far as I know, is new.

I have much pleasure in acknowledging my obligations to Dr. Voelcker and Mr. James Hunter, who have throughout taken great interest in the work at Clifton-on-Bowmont, and supplied me with much valuable matter, which will be found in the appendices.

ROBERT H. ELLIOT.

CLIFTON PARK, *October* 22, 1904.

PREFACE

TO THE

Fourth Edition of "Agricultural Changes."

AS the 3rd Edition of 1000 copies of "Agricultural Changes" is nearly exhausted I offer the present new and enlarged Edition to those interested in land, and to all those who are interested in the welfare of the Kingdom. As writers in the agricultural world have generally alluded to my system as the Clifton Park System of Agriculture I have adopted this description of it in the new title which I have given to my book. Those outside of the agricultural world are particularly asked to peruse Chapter VIII., which has been added to this edition, by which they will perceive that agriculture is certain to become a matter of far greater national importance than it is now. If it is of importance as being our biggest industry, what will its importance be when it one day becomes—as it must for the reasons given in the chapter alluded to—the sole big industry in the Kingdom? After a careful study of the

most recent American works on agriculture, and especially Fletcher's work on "Soils"—(Constable & Co., London, 1907)—I have found ample confirmation of the principles of the agricultural system I have for so long pursued. It may be mentioned that, by a curious coincidence, I have recently received a letter written by a former Ceylon Planter, now farming in Scotland, who has, like myself, practised the same principles in coffee planting and farming, leading in either case to a liberal supply of humus, and the reduction to a minimum of commercial fertilizers. Formerly he had spent £5 an acre on artificial manures in Scotland, now, to use his own words, "not a penny."

It is thought by some that the economy of production in this country that would be caused by my system of farming would not benefit the farmer as it would lead to an increase of rents. It is no doubt probable that it might do so, but it is obvious that a farmer had far better have a higher rent with a safe, sound, and profitable system—involving a reduced demand for capital—than a system involving a larger demand for capital and increased risks. Some have objected to my system that it is too costly as regards seed mixtures. On the average it is, as I have shown, not so, if the cost of these mixtures is divided over the four grass years of the rotation, but I am told that the farmer will not take

this into consideration as he looks at the high initial cost, as compared with the much lower initial cost of the mixtures he usually sows. Here it should be remembered that it is not what you spend that should be considered but what you get for your expenditure, and viewed in that light there can be no doubt that in grazing, in hay, and the enrichment of the soil by the vegetable matter supplied by a four year old turf, the farmer will have an infinitely greater yield from the mixtures used by me, while the old time "windle-strae" farmer has much less grazing, less hay and aftermath, and when he ploughs, having no manurial residue worth mentioning as compared with a four year old turf composed of the large, and deeply-rooted plants supplied by my system, he has therefore to lay out money in top dressing his cereal crops with artificial manure.

In conclusion I may add that I have had most satisfactory evidences of the spread of my system, and of various modifications of it, from all parts of the Kingdom. A widely known agriculturist, after a careful survey of my demonstration farm, wrote to me as follows: "What I saw the other day convinces me that you have revolutionized the methods hitherto pursued, proved to the hilt that the old are very inferior in results to those you advocate, and I cannot but believe that sooner or later what you have so persistently laboured at will be generally

adopted." I thought at the time that the writer had formed too wide a view of the results of my work, as I had originally only intended my system for the cultivation of poor, and worn-out lands, but I am now inclined to agree with the writer excepting perhaps in the case of heavy clay lands.

What a contrast there is between our Government action and that of State action in America! The former through its Board of Agriculture seems not to be able to rise beyond the conception of urging the farmer to put down more and more artificial manures, while the American Government is urging the farmer to cut the fertilizer bill in two by the adoption of the principles advised in these pages.

ROBERT H. ELLIOT.

Clifton Park, Kelso.

November, 1907.

P.S.—The Clifton-on-Bowmont Experimental and Demonstration Farm is always open to visitors, who are requested to give notice of the time of their arrival to Robert Reid, Steward, Clifton-on-Bowmont, Yetholm, who will show them round the farm.

Clifton-on-Bowmont farm is distant from :

Kelso (Railway Station),	8½ miles.
Yetholm (Post Town),	1½ miles.
Mindrum (Railway Station),	6 miles.
Clifton Park,	4½ miles.

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ERRATA.

On page 152, line 11, for "six times their natural size," read "six diameters"; and on line 12, for "ten times," read "ten diameters."

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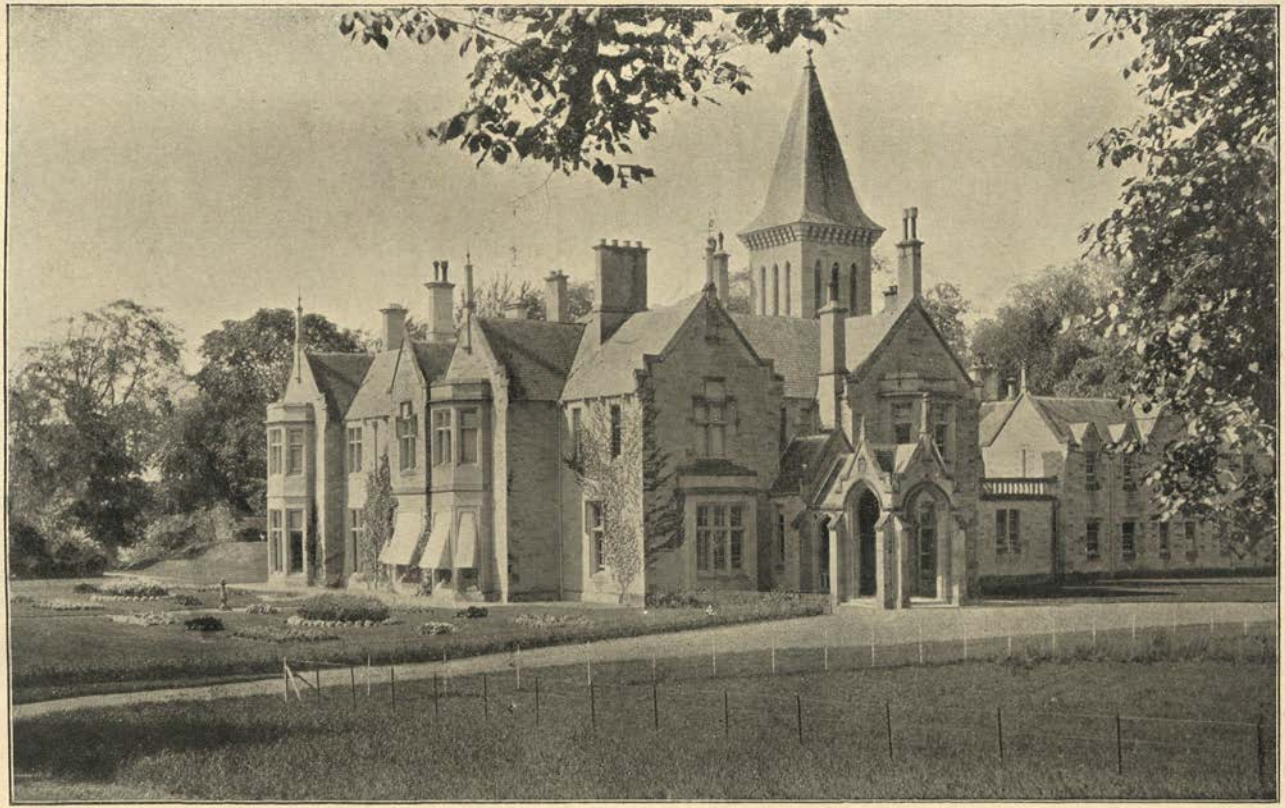

CLIFTON PARK HOUSE, ROXBURGHSHIRE.

THE CLIFTON PARK SYSTEM OF FARMING AND LAYING DOWN LAND TO GRASS.

CHAPTER I.

INTRODUCTORY.

"Truth," says Milton, "is compared in scripture to a streaming fountain; if the waters flow not in a perpetual progression, they sicken into a muddy pool of conformity and tradition." Just as the spiritual sluggard allows his religious affairs to remain in the groove in which he inherited them so does the agricultural sluggard, to save himself the trouble of thinking, allow his affairs to be ruled by conformity and tradition while the condition of the world calls loudly for the agricultural changes which are necessary in order to bring our system into line with the altered conditions of the present age.

IT will, I think, be satisfactory to the reader to be told at the outset that I am an agriculturist by profession, having started as such in 1856 in India as a practical planter—*i.e.*, a planter managing and working his own land. For upwards of thirty years I have farmed land on my property in Roxburghshire, and still have in my occupation a farm of about 1250 acres. The opportunities I had for being acquainted with the world-wide causes which were sure to bring about a serious state of agricultural conditions in these islands showed

me that a thorough reorganization of our farming system was necessary in order to bring it into line with the altered conditions caused by foreign competition, and the rapidly-increasing transport facilities which were sure to bring the produce of the world more and more cheaply to our doors. To myself, then, and to others who had equal opportunities of making sound forecasts, it was evident that a system of cultivation depending largely on cereals would have to give way to one mainly depending on the cultivation of grass and forage plants, and also on cheapening the cost of production all along the line, for it was evident that if other countries could produce so much more cheaply than we can we must produce more cheaply than we do now or go to the wall. It was extremely easy to conceive these ideas, and I accordingly at once proceeded to attempt to put them into execution; but I was not long in discovering that I had got hold of a very difficult and complicated subject, and so much so, indeed, that it is only now, after more than thirty years' practical experience on a large scale, and after numerous experiments on all kinds of soil, and at many different elevations, that I feel myself able to offer to the agricultural world experiences and conclusions that will, I venture to think, be of use in the work of remodelling our own agricultural system so as to bring it into harmony with the existing state of things throughout the world. But though I have no doubt that my experiences will be of value, I need hardly say that, before adopting any of the changes to be advocated in these pages, the agriculturist must weigh carefully the whole of his own local conditions, and see that, if he adopts any of my conclusions, he carries them out down to the minutest particulars. For laying down land to grass, and more especially the subsequent management of the pasture, requires great skill and attention, and what to an agriculturist who is inexperienced in laying down land to grass may seem a trifling matter is, if neglected, often the cause of an en-

tire or partial failure. And I am the more particularly reminded of the necessity for this caution when I think of the first and last parts of the following sentence which Dr. Paris wrote in his memoir of the great Arthur Young:—"For it has been said," wrote Dr. Paris, "and perhaps not without justice, that the writings of Arthur Young produced more individual harm and greater public good than those of any person who had ever written; but the former inconvenience must always attend the introduction of any new system, of general application, that requires prudence and skill for its successful direction." In other words, many agriculturists seem to have adopted Arthur Young's advice, but did not put it into execution with skill and prudence, and hence inflicted much injury on themselves. But, it may be remarked, though the careful weighing of local conditions is obviously of the greatest importance, both as regards the selection of seed and the proportion of land to be kept in grass, the farmer may, as to the latter point, proceed with considerable confidence, for errors of judgment as to the proportion of land that should be kept in grass are easily repaired should the error lie in laying down more land to grass than should afterwards prove to be advisable, as grass land, it seems hardly necessary to say, is readily convertible into arable, while arable cannot be converted into grass without a considerable lapse of time, unless the land, which is rarely the case, should have in it an ample supply of humus, and is thus in good physical condition.

There is also another point connected with the future prospects of agriculture to which I would direct especial attention, and that is that the system of farming which must now be adopted in these islands is one highly suitable to the habits of gentlemen, and others who do not feel inclined to rise early and eat the bread of carefulness. The farming of the future, therefore, will carry with it less risk of loss either to the landlord or

to those who may choose to adopt farming as a profession, but who are not of the farming classes. And this consideration makes it highly probable that, and to the obvious advantage of our future prospects, much more capital, enterprise, and intelligence will be attracted to farming than is now the case. This remark has been suggested to me by the admirable advice given to landholders by Dr. Keith (in his "General View of the Agriculture of Aberdeenshire"), who advises them in general "to be contented with raising grass and green crops, and a small proportion of corn, remembering that a tenant who rises early, and is his own bailiff, or farm overseer, is best qualified to be a corn farmer." To suit the advice to these days, and for the general use of all agriculturists, instead of "a small proportion of corn," we should say the smallest possible proportion of corn.

It must further be considered in this connection that the system of farming to be afterwards recommended as the one most suited to the times, not only, as I have said, carries with it less risk of loss, but ensures good crops of all kinds, whether the seasons may be over-wet or over-dry. For the system provides a deeply-tilled and humus-fed soil, and when you have both you have those physical conditions which make failures in crops an impossibility, for, as has been pointed out by Mr. Hall in "The Soil"—"Mechanical texture is of fundamental importance, and many soils owe their value to this property alone, as is evidenced by the high rents obtained in East Kent for soils which contain but little plant food, but which are of uniformly fine texture owing to the fine-grained sand or silt of which they are composed." And if this is the case with such soils, how much more productive must soils be which are cultivated on my system, in other words amply supplied with humus, and deeply tilled, aerated, and drained by the agency of the deep-rooting plants which are recommended in my mixtures.

In continuing these introductory remarks, I may be allowed to observe that, notwithstanding our present unsatisfactory agricultural conditions, I by no means take those gloomy views of our prospects which are entertained by a large number of my countrymen. Such views, I admit, are perfectly justifiable if any attempt is made to plod on with a system which was very suitable to the conditions of twenty years ago (though even then many modifications could have been profitably introduced), but which is entirely out of joint with times when constantly-improving communications are bringing us more and more into competition with cheaper labour and better climates. But, judging by the financial result of my own farming in recent years, I see no reason to despond if we turn our attention to altering our system of agriculture in the direction of limiting our cereals to the utmost, producing them at the lowest possible cost, and introducing improved grasses and other kinds of forage plants. For we have an admirable forage-growing climate, and it must be remembered that the same communications which flood our country with agricultural produce can also bring hither cheaper feeding stuffs and manures, and that these have consequently already largely declined in price in recent years. And if these aids are taken full advantage of, and the necessary changes in our system are carried out, British agriculture will gradually rise, not perhaps into as profitable a state as it occupied in the best of times, but into as secure and satisfactory a position as any in the world.

Finally, it should be considered that the system I have to advocate—one depending entirely upon stock—will be much safer than our old arable culture. For with that we had the maximum of risk, combined with the maximum amount of destruction to the fertility of the soil. And as to that point we have the testimony of the first great meeting of 400 Aberdeenshire farmers, held upwards of twenty years ago, who declared that one

of the three great causes of their difficulties was the exhaustion of the soil. But the system which I have to urge in these pages will continually enrich the soil, and, what is often of greater importance, improve its physical condition. And it may be well to notice in this connection that the system to be proposed will not only suit the times, but also the interests of both the landlords and tenants. Formerly, their interests were in a great measure opposed, the object of the tenant being to take all he could out of the land, and the object of the landlord to retain all the strength he could in it; and, with the aid of artificial manures, the tenants have been only too successful in depleting the soil, and, in a large number of instances, after having sucked the orange, have thrown the empty peel in the landlord's face. But with the system I advocate it will be as much to the tenant's as to the landlord's interest that all the strength possible should be retained in the land, for, in the future, on no other principle can farming in these islands be profitably carried on. And here it may not be uninteresting to notice that similar principles were laid down by M. Porcius Cato (born 234 B.C.) in his agricultural treatise, "De Re Rustica." He was asked what was the most certain profit rising out of land. "To feed stock well," he replied. Being asked what was the next point of importance, he said, "To feed with moderation." Evidently meaning to the extent that paid best, or, in other words, that the farmer should aim at a low cost of production. He also, I may add, laid down that "a good husbandman should be a seller rather than a buyer," which, of course, means that he should breed his own stock, and produce for himself everything that he profitably can. And it seems hardly necessary to add that the Act which now requires that all imported animals should be slaughtered at the port of debarkation still further enforces the necessity for adhering, as far as possible, to these old Roman agricultural maxims. It is interesting to note that Cato

estimates the value of manuring as below ploughing, and thus recognized as Sir John Lawes did that the physical condition of the soil is of more importance than its strictly speaking chemical composition. "If I am asked," says Cato—"what is the first point in good husbandry, I answer good ploughing; the second ploughing of any kind, and the third manuring." "In a very important sense tillage is manure" (Bailey's "Principles of Agriculture," New York, Macmillan, p. 65). Tillage by the agency of roots is the best and by far the cheapest form of tillage, and that it is the best anyone can see for himself by digging up the soil in forest-clad land, and that it is the cheapest as well as the best in arable land is evidenced by the great depth to which chicory and burnet roots penetrate.

I may next allude to a difficulty, with a view of explaining it, and suggesting a remedy. And it is a very important difficulty, and one that has often been wondered at, and—shall I say?—ignorantly wondered at. This consists of the severe resistance to agricultural changes, which was well exemplified by the English farmer who, when some agricultural changes were suggested to him, simply said, "What we knows we knows, and what we don't know we don't want to know." On mentioning this to a landed friend who is interested in agriculture, as well as many other subjects, he said, "Why, that is just the case with the landlords in my county, and they don't know, and they don't want to know, nor to trouble themselves at all about the subject." And in Johnston and Cameron's book on agricultural chemistry, it is stated that "the reception of scientific results and suggestions by the agricultural body generally have been so ungracious that little wonder can exist that so many chemists have quitted the field in disgust, and that the majority of capable men should studiously avoid it." And I may mention that when lately making some inquiries relative to the subject of this book at the

rooms of the Royal Agricultural Society in London, I was told by the clerk that never in his experience had a farmer come there to ask a question, or go into an enquiry of any kind relative to agriculture. He should have said that farmers rarely do so. Planters in India, like farmers here, will not read, as both have probably taken to cultivation from a liking to out-door life, and an indisposition to any form of intellectual exertion. Then it must be considered that the sharp lads in families are generally sent into law, or trade, or medicine, while the duller are considered to be only good enough for agriculture, or planting, where study, though quite as essential as in other professions, may be neglected without much loss until changing times require important modifications of system. As for our farmers in Scotland, I have often said to some of them that I believe most Scotch farmers would go five miles out of their way to avoid seeing an agricultural improvement. And yet all farmers are ready enough to adopt improvements in the shape of improved stock, and agricultural implements and machines; and the explanation of their resistance to agricultural change is that they cannot afford to attempt improvements which are to them of a more or less speculative character, and are afraid of being persuaded to adopt measures which may turn out to be failures. An improved animal they can see, and from it gain an immediate and certain result, and the same is the case with an improved or new implement. But the return from any new course, such as altering their rotation or laying down land to grass, either permanently or for five or six years, requires a considerable time in order to prove the utility of so doing, and, in the case of grass in especial, they are hampered, no doubt, by that part of the old saw as to "making a pasture breaking a man"—a saw once most true in consequence of bad and improper seeds and bad methods of laying down, and not so very long ago, but now most ridiculously false, as I

shall afterwards clearly show. And now I come to a most important point, to which these remarks naturally lead up, and to which I desire to direct special attention.

I have said that our farmers are afraid to attempt agricultural changes which *to them* are of a more or less speculative character. I have italicised the words "to them," because the very agricultural changes to be recommended here are precisely those which have been adopted in the La Manche district in Normandy, where the farmers have universally given up cereals for permanent pasture, and this, too, notwithstanding that they had the so-called advantages of Protection. Just enough land is now given up to wheat for household consumption, to buckwheat for the food of pigs and poultry, and to roots, lucerne, and other temporary pasture sufficient for the winter food of live stock. The adoption of this course is universally considered to have been the saving of farmers of La Manche. A similar course would have been the saving of farmers in many parts of these islands. Why, then, were such changes of front not at once adopted here? Why did the farmers of Normandy evidently not consider them to be of a speculative and risky character, while to our farmers they evidently were so? But a reference to our Cherbourg consul's report throws full light on the subject, and we find that he attributes the happy change in La Manche to Government aid in the shape of agricultural schools and experimental farms. Had we had such advantages here, I see no reason to doubt that our farmers would long ago have had recourse to these steps which were the saving of their brethren in La Manche; and our landlords and land agents, having had equal opportunities, would have readily joined the tenants in aiding to bring about the necessary changes in our agricultural system. But there was ignorance all along the line—a natural dread of embarking on new courses which might prove to be failures, and no means of enlightenment at hand in the shape of

Government schools and experimental farms to show how the necessary changes could be best carried out. And has it not been evident to every civilized Government but ours that whereas a question in chemistry or machinery, or of any new method of manufacturing, can be brought to exact proof, and instantly decided one way or another, an agricultural problem not only takes years to work out, but is liable to be extremely difficult of solution owing to the great variety of circumstances and the numerous climatic causes which disturb the results of farming experiments? And seeing that farmers and landlords pay taxes, are they not, therefore, as much entitled to Government aid as science, art, education, or any of the other subjects which are aided by the resources of the State? But it is now time to turn to a consideration of the whole subject before us, and, in concluding these introductory remarks, I only desire to add that if a certain amount of repetition is to be found in these pages, it is because I think it will be useful to those to whom the subject is new.

CHAPTER II.

GENERAL PRINCIPLES.

IN the treatment of almost any subject it is hardly necessary to say that there is generally some leading point, or principle, which mainly governs it, and which should be constantly kept before the attention. As regards religion, for instance, Confucius was once asked whether it might all be condensed into one word. "Certainly," he replied; "is not reciprocity such a word? What you do not want done to yourself do not do to others." And so, to take another instance, the whole of the agricultural competition we mainly suffer from may be condensed into one expression—the cost of heat, for those who compete most successfully with us are enabled to do so because they obtain gratis from the sun a large supply of what we have to pay very highly for in the shape of clothing, lodging, and fuel; and it is hardly necessary to point out that in India and mild climates, like the best of Argentina, the labourers' expenses are necessarily far less than those of our islands. To turn to the point with which we are more immediately concerned, it may be said that the solution of all our agricultural difficulties, so far as they can be solved by the wit of man, resolves itself into one expression—the cheap production of a good turf. That is the principle which, as I shall show, dominates the whole subject, and that it does so is evident if we consider carefully the following points:—

I. The success of our agriculture depends on the cheapening of production.

II. The cheapest food for stock is grass.

III. The cheapest manure for soil is a turf composed largely of deep-rooting plants.

IV. The cheapest, deepest, and best tillers, drainers, and warmers of the soil are roots.

But before proceeding to prove that a cheaply-created turf is the only solution for our agricultural difficulties, it may be well to notice the solutions that are thought by some to present certain prospects of cure for the unfortunate conditions of our times; for, by first of all disposing of these, we shall be able to fix our attention more exclusively on those factors which alone can set our agriculture on a footing with the requirements of the age.

Only let us have bi-metallism, assert some, and prices will rise, and our old system of farming again become profitable. Only, declare others—and no doubt a very considerable number—let us have Protection to an amount that would raise corn to a paying level, and all would go well with our agriculture. Only let us have good land legislation, and improved means of securing the interests of the farmer, and our agriculture, with a vastly-increased capital spent upon it, owing to proper security for the tenant having been provided, would again flourish exceedingly. As to the first, we have no means of proving what would occur if bi-metallism was adopted, and there seems to be no prospect whatever of any such general agreement on the subject amongst the nations of the world as would enable any system of bi-metallism to be carried out. And, as for the second point, there seems to be quite as small a prospect of Protection ever being adopted in England within any time worth considering. Nor, unless it were carried out to a very high amount, have we reason to suppose, judging by what has taken place close to our shores, that Protection to a moderate amount could so far favour the farmer as to make grain for sale profitable. For in France there is Protection, which gives the agriculturist there 8s. 2d. more per quarter,

and yet what have the farmers in La Manche, in Normandy, done? As we have seen, they have given up the growth of cereals for sale in favour of permanent pasture, and now only produce enough grain for consumption on the farm. Then, as to the third point—land legislation—we have only to turn back to the most prosperous times, to the time when farmers laid out most capital on the land, to see how little the laws can affect the farmer; for in these good days we had the laws of hypothec, which were always said to be so injurious, and we had neither the Agricultural Holdings Act nor the Hares and Rabbits Act. These were the days of high rents, too, and yet one of the largest scale cultivators in the South of Scotland once said to me, "I could make money in those days, but I cannot do so now." Nor, with the present system of farming, could he do so with the aid of all the laws that human folly could devise. Those, then, who hold up bi-metallism, Protection, and land legislation as cures for our agricultural difficulties have little idea of the harm they are doing in dangling false hopes before the eyes of the farmer, and so retarding the adoption of the only practical remedies for the present agricultural situation. For is it not evident that all our attention should be concentrated on the practical remedies within our reach, and which can be immediately applied?

Lastly, in this connection, it should be considered that, whether the remedies held out by bi-metallists, Protectionists, or the legislative cure-mongers come to pass or not, the steps recommended by me will be equally advisable; for if corn growing should never again become profitable, there can be no doubt of the good that will arise from the adoption of the farming system recommended in these pages; and should corn growing for sale again become profitable, then the land laid down to temporary pasture, on a system of not less than four years in grass, may have the system shortened to three years, or even to two, and both

such lands, and those laid down to permanent pasture, again brought under the plough will be the more fitted for profitable corn growing than ever they were before.

I have said that the production of stock at the lowest possible cost is what the farmer has solely to rely upon, and this, of course, involves the production of their food at the lowest possible cost. Both these facts must obviously govern the farming policy of the future. How, then, can the farmer most cheaply provide food for stock? This, again, depends, of course, as to the way manure can be most cheaply supplied. Now, as every gardener and cultivator well knows, the cheapest and best form of manure is a good turf, for the decaying sod not only supplies the plants with food, but, what is nearly as important, and some might say of even greater importance, provides a good nest, or, in other words, good physical conditions in the soil. And it was on this turf that for so long a large proportion of our agriculture in Scotland depended, when vast quantities of land, enclosed within the last fifty or sixty years, were ploughed up. But in the process of time this resource has become exhausted. It must be again supplied, and this can only be effectively done within a moderate period of time by growing a mixture of large-rooting and deep-rooting plants, managing them well after they have grown, and giving them four to six years' time to form into a turf. When, then, the farmer again ploughs up the land, he will start his rotation with the same advantages which the farmers had when they enclosed and ploughed up old pasture lands; he will thus be enabled to produce good crops at the smallest expense,* and without the aid of any manure, excepting some artificials with his turnips, and

* It is important to remember that the farmer using the 4 or 5 course rotation has to go to the expense of sowing grass seeds twice, while with my 8 years' rotation there is only one sowing of grass seeds.

eventually without any when the land has become sufficiently charged with humus.* But this process must only be continued for four years, during which a turnip crop, taken after ploughing up the grass, should be taken, followed by a cereal crop. Then a root crop should be taken, and the following year the land again laid down to grass with a light cereal crop, and the process of forming a good turf recommenced. Every time that this course is repeated the land will become richer, and warmer, and the soil more thoroughly and deeply disintegrated by the roots of plants, and therefore more able to yield better and more certain crops, and crops less liable to the attacks of disease; this is especially so as regards the turnip crop, which is little liable to finger-and-toe if repeated on the same land only after a long interval. The formation of this turf will also cheapen the processes of cultivation in two ways, for it is hardly necessary to say that land deeply and thoroughly permeated with vegetable matter is much more easily ploughed and worked; and I have found that if the land is well filled, when laid down, with a mixture of plants which have a large and powerful root system, the couch grasses are extinguished, or nearly so, and the expense of cleaning the land, when again brought under plough, absolutely abolished.† On the rapid creation, then, of a turf composed of plants calculated to leave the largest amount of vegetable matter in the soil, and of plants well able to resist drought, and contribute by their qualities to keep stock

* Potatoes and turnips have now been successfully grown at Clifton-on-Bowmont farm without the aid of any manure, except that supplied by the turf (*vide* Appendix III.)

† For the last fourteen years there have been no weeds worth removing. Subsequent experience has shown me that, in order to abolish the growth of weeds, taking a turnip crop after grass is essential; but, as shown elsewhere, when the farm has once been so thoroughly cleaned that there are no weeds on it worth removing, then the farmer, if his plans make it expedient, may begin his rotation with oats out of lea instead of turnips.

in good health, the future of our farming, so far as the arable portion of our lands is concerned, depends; and it is hardly necessary to say that the same principle applies to the creation of permanent pastures. Chicory, it is worth noting here, would decline and almost disappear (though we still have some of it in a pasture fourteen years old) from a permanent pasture, but it must be remembered that its very deep roots which have been traced down upwards of 4 feet, will, when the plant has died, leave passages in the soil down which the roots of other plants will descend to feed at greater depths in the soil than they otherwise would. Having thus stated what I conceive to be the governing principle of the subject, I now propose to advance, in the following chapters, to a careful consideration of the whole important subject of the best, most rapid, and the cheapest way of creating a good turf; but before proceeding to do so, I wish again to recur to what I have previously alluded—the danger of misapplying the general principle I have dwelt upon, and it is the more necessary to do so because I know of no subject as to which you will hear so many contradictory opinions, and as to which one is more liable, from various causes, to come to erroneous conclusions, seeing that the reckoning to make a farming conclusion correct consists of so many items, that there is therefore a great difficulty in collecting all of them into one view, and a still greater difficulty in estimating their comparative value. A guide to the understanding, then, should be ever near, and I know of none equal to Locke's "Conduct of the Understanding"—a small book of about 100 pages, the most convenient edition of which (Fowler's) may be bought for a few shillings. A careful study of this little volume will keep the mind active to the reception of new ideas, and aid it in carefully collecting and weighing, and re-weighing, all the points that bear upon the present complicated agricultural situation; it cannot be too highly recom-

mended to all those who are engaged in carrying out the changes that are necessary to enable us to manage profitably the land of Great Britain. The situation, indeed, with reference to foreign competition, and agriculture itself, is so complicated that the student might well turn away from the whole subject in despair, unless he follows the admirable counsel of Locke in the section on "Despondency," where, as the reader will observe, his teacher leads to the inference that it is of much more importance to teach method than to impart knowledge. And if Locke is to be recommended to the farmer, he is still more to be advised for the use of agricultural chemists, who have, as I have shown in my paper delivered at Cambridge, (*vide* Appendix IX.) led the farmer to most pernicious conclusions, because, as Locke puts it, in his section on "Reasoning," "something was left out which should go into the reckoning to make it just and complete."

And, besides the danger of misapplying general principles, there are numerous cases where erroneous conclusions are readily come to, as, for instance, that because one seed is cheaper than another it will therefore afford a larger return of grass for the outlay, or, that because some of the richest pastures contain certain plants it is therefore most advantageous to sow the seeds of them, or that because you want much clover it is therefore desirable to put down much seed. The whole subject, in short, is a jungle full of traps by which the unwary are only too liable to be caught, and it is therefore important to begin with that attitude of mind, so difficult to attain, which enables the individual neither to believe, nor, what is of even more importance, disbelieve anything whatever without sound reasons for forming a decisive opinion in one direction or another.

Since writing this chapter Lord Leicester has been kind enough to inform me, in answer to a letter from me on the subject, that he has no objection to my publishing a paper on the system he has adopted,

and which, in principle, is exactly the same as the one I have pursued, so far as leaving the land for a certain number of years in grass, and then taking four crops in succession, is concerned. His Lordship's paper is as follows:—

"As many enquiries are made as to the system I adopt in treating poor lands under temporary pasture, I may state that it is necessary to carry out the following plan to obtain a satisfactory result. The seed should be selected from those natural grasses that appear to thrive best in the waste places in the locality in which the pasture is to be formed. The seed should be purchased guaranteed as to purity and germinative power. It is most important not to feed the pasture close with sheep during the summer, when the grasses are in full growth, or the more valuable grasses would perish, and weeds and moss take their place; more especially is this necessary in the treatment of permanent pasture. I have, as an experiment, left on very poor soil a pasture down for sixteen years, and I do not find that the herbage has diminished; but there is no doubt that pastures are of most value for the first few years after being laid down, when they are exclusively given up to the feeding of sheep. If the land is to accumulate fertility, and enable four profitable crops to be obtained without the application of any manure, the minimum time under which the land should remain in pasture would be six years.

"I believe that it is generally the practice that the first crop on breaking up of a pasture should be a corn crop. I think that this would be fatal to obtaining three crops following without the aid of manure. If the land were thoroughly clean, as it should be when laid down to grass, when broken up after being down for several years it will be very foul. It is probable that no merchant can deliver natural grass seeds absolutely free from the seeds of couch grass.* Clover seeds may be obtained free of

* *Note by Mr. Hunter, Chester.*—The seeds of the true couch grass *Triticum repens*) are seldom found in grass seeds of other species in general use, and they should never be present in properly-machined seeds, because, being larger than ordinary grass seeds, and as two or more of them usually adhere together, their removal from other species is easily effected. The reproduction of *Triticum repens* is not, however, from seed, but from the creeping underground stems which send up shoots from

all weeds, but not so grass seeds. The cost of cleaning after a corn crop, when the land is foul, is very considerable, and nearly the value of the crop is consumed in the process; besides, I believe that the constant cultivation that would be necessary would utterly pulverise and destroy the flag * that had been ploughed in, thus reducing the land to its former unfertile state, and precluding the possibility of its producing, without the aid of manure, three more profitable crops. It is a fact well known that very poor soils † are injured by constant cultivation and exposure to the sun, though such a procedure is necessary when the land is foul. If a root crop is first taken the pasture should be ploughed in the winter, and cross ploughed in the spring. I have never known a summer when, between March and July —till which latter month rape or turnips should not be sown—it has not been easy, at a trifling expense, to destroy any vitality that may exist in the flag. The flag should be ploughed in just previous to the sowing of a crop of rape or roots, pressed with a drill-roller, and, should there be any life left in thistles or couch, the extraordinary luxuriance of the rape or turnips would entirely destroy all life; during the time the land was under cultivation not a weed of any kind, except the annuals, the seed of which is in the soil, would appear.

"I think that it is evident that under this system the accumulated fertility of the pasture is not exhausted by the four crops, as I have this year had nearly six quarters of barley per acre, the fourth crop on a forty-acre field, and a considerably better yield than I have obtained on the good land farmed under the four-course system; these poor lands after pasture usually produce better crops than the better lands. The root crop would in the first year disintegrate the flag, and prepare

every joint. Other species of grasses, such as smooth-stalked meadow grass and bent grass, are also known as couch grass, and both these species produce abundance of seeds, which may be either in the land sown down or in the purchased grass seeds. The seeds of all agricultural grasses in ordinary use can be obtained absolutely free from the seeds of couch grass, and all kinds of grass seeds may now be obtained of as high a degree of purity as that of clovers.

* Flag is equivalent to turf.

† *Vide* "Decomposition of Vegetable Matter on Warm Slopes." Appendix III.

the land for a much heavier crop of corn than if the corn was sown immediately after the pasture. In fact, in my opinion, a crop of roots preceding a crop of corn on the first breaking up of the pasture is in every way the more desirable process."

The seeds used by Lord Leicester were the following:—

Seeds for Temporary Pasture on Light Lands.

	lbs.		lbs.
Cocksfoot	4	Meadow Fescue	2
Perennial Rye Grass	2	Hard Fescue	1
Italian Rye Grass	2	Tall Fescue	1
Timothy	1	Alsike Clover	1½
Tall Oat Grass	1	White Clover	1
Golden Oat Grass	¼	Yarrow	¼

Total, 17 lbs. per acre.

It will be observed that Lord Leicester says that the minimum time during which the land should remain in pasture is six years, and, with the mixture he uses, I have no doubt that that time would be required in order to accumulate a sufficiently good turf. But if a mixture is used containing a large quantity of cocksfoot and yarrow, and other plants calculated to fill the land with vegetable matter, then I think that a good turf, and one much better than would be obtained in six years from the mixture Lord Leicester uses, could be produced in four years, and with the aid of the following mixture, which I have used with success:—

	lbs.		lbs.
Cocksfoot	10	Burnet	8
Tall Fescue	5	Chicory	4
Tall Oat Grass	5	Kidney Vetch	3
Crested Dogstail	1	Parsley	1
Hard Fescue	2	Alsike Clover	1
Golden Oat Grass	1	White Clover	2
Rough-stalked Meadow Grass	1	Late-flowering Red Clover	2
		Yarrow	1

Total, 47 lbs. per acre.

The cost of this mixture ought to be (prices vary almost every year) about 50s., and if the land is

left in grass for five years, the cost per annum will be about 10s. per acre, the same as a farmer now spends per annum if he leaves his land two years in grass. As Lord Leicester has pointed out, it is most essential that, on ploughing up the pasture, a green crop should first of all be taken; and I may even go so far as to say that to adopt any other course would be to insure a partial, and, perhaps, a very considerable failure when the system is first begun, though, as I have elsewhere pointed out, the second rotation may be begun with oats, should this be more suitable to the circumstances of the farmer. I may here mention that there are two objections to beginning the rotation with oats—the first, and by far the most important, is that weed seeds blown on to the surface of the land are ploughed down and so conserved all winter to germinate in the spring, where along with other weeds that may be present in the land, they must be left undisturbed till the corn is cut, when all the seeds ploughed down add to the expense of cleaning the land for turnips in the year following. But if turnips are taken the first year, nearly all the weed seeds are sprung, and the plants from them, along with other seeds present, are destroyed by the cultivation, and then by the second turnip crop of the rotation the land is so thoroughly clean that to begin a second rotation with oats is less objectionable on the score of weeds. After the land is thoroughly cleaned by the two turnip crops of the rotation, turnips might be taken out of lea and the land laid down the year following with a crop, should this suit the plans of the farmer—in other words, the eight years rotation I recommend and practise, could be turned into a six years rotation. I may here add that the main principle of my system is that the land should not lie less than four years in grass, for, as shown by Dr. Voelcker's analysis (*see* Appendix IV.), there is much more rootage in the fourth than in the third—in other words, much more vegetable matter to plough down for the obvious benefit of the fertility of the soil.

CHAPTER III.

ON DISINTEGRATING THE SOIL AND PERMEATING IT WITH VEGETABLE MATTER.

ONE of the most important points to be considered in the whole subject of laying down land to grass is the disintegrating or finely breaking up of the soil, and the intermingling with it of a sufficient proportion of vegetable matter, so that the soil may provide a good nest for the plant; for, as Sir John Lawes has well pointed out, it is the physical condition of the soil, its permeability to roots, its power of absorbing and radiating heat, and its power of absorbing and retaining moisture, that is of more importance than its, strictly speaking, chemical composition. This is a sentence, I need hardly say, that every agriculturist should learn by heart, and keep constantly before his attention, and especially in connection with laying down land to grass; for it is in consequence of the neglect of what Sir John has so well pointed out that failures so often occur, and the power to which he alludes of absorbing and retaining moisture is probably of supreme importance, for however abundant plant food may be, it must be remembered that it cannot enter the plant except through the medium of water. It is most unfortunate that all our agricultural text-books should have given undue relative importance to the subject of agricultural chemistry. It should be carefully kept in mind that this is only one branch, and by no means the most important, of the many-sided problem of agriculture. It must always be remembered that a soil may be chemically rich, and yet in productive power be far inferior to one chemically poor, as shown, for instance, in the illus-

tration given on page 4. In this connection I may quote the following advice given by my late friend, Mr. Faunce de Laune, to a correspondent, under the following circumstances:

The land, as to which his opinion was sought, was thus described to him:—

"The land is desperately poor land. It has been let lately at 2s. 6d. per acre, and the tenant is leaving; before that it was let at 5s., and seven years earlier it was let at 20s., but the tenant failed. The tithe is 7d. on most of it, and rates at 2s. in the pound. Not much money is to be expended, and what is to be done?"

"I advised," he says, "that the land should be frequently harrowed, and in the spring grass seeds, according to my No. 3 Table, for light chalky soils, sown; that it should be harrowed again, and left to Nature for fourteen months; and after that time it should be lightly fed with bullocks or sheep, the animals, if possible, to be fed with decorticated cotton cake."

The accumulation of rent, rates, taxes, tithe, and cost of seed would amount to about 30s. per acre, and if the land should be worth 1s. 6d. an acre extra at the end of the year, it would pay the interest on the capital expended. He then adds the following observation, to which I particularly wish to direct attention:—

"How far the accumulation of decaying vegetable matter, whether weeds or good grasses, goes towards manuring the land, and more especially how much it disintegrates the soil, so as to allow the inferior pasture grasses to grow, has not been a subject sufficiently studied; but the more attention and time I give to this subject, the more convinced do I feel that if on very poor land such courses as are described are carried out, Nature, assisted in the inexpensive manner above described, can and will improve the quality of the soil, and this at a less costly rate than by the artificial means of husbandry. Truly, Nature can be aided by supplying the seeds of those pasture grasses which are most beneficial to stock, but then I consider that expenditure should cease on such land as this.

"On a deserted farm in Essex, which I once visited, I noticed plants of cocksfoot and timothy accidentally sown, and growing

with the utmost vigour, being evidently supplied with nourishment from decaying thistles and other weeds.

"Farming, as it is practised now, is more often the act of destroying natural fertility than adding to it, and it is therefore no wonder that the land becomes impoverished."

Mr. Faunce de Laune, elsewhere in his proofs, quotes the opinion of the late Mr. T. Carington (*Journal Royal Agricultural Society*, vol. xv., p. 490), who observes that "no person who has not had experience will appreciate fully the difficulty and tediousness of the operation of converting into really good turf poor strong land which has been constantly under the plough for generations, and in which every bit of vegetable matter has been used up by the practice of having periodical dead fallows dressed with lime."

The preceding remarks I have quoted all indicate the really great difficulty connected with laying down land to grass—the want of good physical conditions in the soil, which can only be supplied by permeating it with vegetable matter. The manurial conditions, from a strictly speaking chemical point of view, may be good, but they cannot make up for the want of good physical conditions; and the more I have studied the whole subject by the light of theory confirmed by practice, the more certain do I feel that the importance of keeping up a good physical condition of soil, though generally recognised, has never been sufficiently acted up to.* My first practical experience regarding this point dates a great many years back, and has ever since been the

* The Italians, in some cases, cut gorse and heather, and pile the cuttings between the rows of vines, and leave them (the gorse and heather) to decay, after which the decayed vegetable matter is dug in, in order to supply the soil with humus. It is interesting to observe how man everywhere found that this vegetable matter must be supplied, and that no chemical manures can take its place. This has been equally found by the Italian vine grower, the tea planter and coffee planter of India, and it must every day become more and more apparent to the cultivator of the humus-exhausted soils of Great Britain.

C. de LAUNE FAUNCE de LAUNE, of Sharsted Court.

means of my continually observing and studying the effects of the presence or absence of good physical conditions of soil. I think it would be difficult to find a more thoroughly practical experience than that which I will now proceed to describe.

In conjunction with a planter friend in India I once endeavoured to ascertain the consumption by coffee trees of potash, with the view of seeing how far it was advisable to add it to our manures, and there were accordingly taken with great care two samples of soil—one from the virgin forest land, and the other from land immediately adjacent to it, from which twelve crops of coffee had been taken without any manure being applied to the soil. The samples were sent to Professor Anderson, of Glasgow University, and he was asked to spare neither pains nor expense in carefully examining the soils, with the view of seeing how far the cropped soil had been exhausted of potash. The result seemed at first sight to be remarkable; for the soil from which the twelve crops had been taken was found, from a chemical point of view, to be very little deteriorated except as regards lime, which was rather less than in the virgin soil. But the explanation evidently was that the leaves shed from the shade trees and stones decaying in the soil had supplied the small quantity of potash and other ingredients removed by the crops. "Why, then," asked my friend, who had called on the Professor to hear the result of the inquiry, "can young coffee plants easily be grown on the virgin soil while we have the greatest difficulty in growing them on the cropped soil?" "Simply," was the answer, "because the virgin soil is in a fine granular state, and in perfect physical condition, while the soil in the plantation, after having been rained upon, and walked upon, and exposed to the elements, has lost its original fine physical condition." In other words, it had become more or less consolidated, and therefore was a bad nest in which to grow young coffee plants. Here, then, we have an

important practical illustration of what, I feel sure, must frequently be the case—namely, that what is often attributed to manurial deficiency, or, in other words, poverty of soil, is largely owing to physical defects. And if these tell largely on a, comparatively speaking, strong shrub like coffee, how much more must they tell on tender-rooted grasses, and how much, further, must such deficiencies tell in a climate like ours, which is so much subject to changes which tend to run the soil together, and so injure its physical condition. And if, again, a planted-out plant of coffee is, as we have seen, liable to fail from being put down in a defective nest, how often, too, must grass seeds fail from a similar want of a proper home to germinate in, and how frequently must the tender, newly-grown grass plant fail from the want of suitable conditions for establishing itself in the soil. I think, then, that a little consideration of these points will show that I may safely declare, as I have in the beginning of this chapter, that one of the most important points connected with the whole subject of laying down land to grass, either to lie for a period of years or permanently, is the disintegration of the soil, and the intermingling with it of a sufficient portion of vegetable matter, so that, after being disintegrated, it may not readily again run together. The question which naturally occurs is this—How can such conditions be most economically provided? And, first of all, let us take the case of laying down land to permanent pasture.

When laying down land to grass, the usual practice has hitherto been to do so after a crop of turnips, and when the land has, in the course of its previous cultivation, been regularly supplied with farm-yard manure, and thus with applications of vegetable matter, and is of a quality that does not readily run together, and so becomes tough and hardened, there is nothing to be said against so doing. But where the land has not been well supplied with vegetable matter, or is of a quality which

soon loses whatever physical condition has been imparted by tillage, I have now reason to think, from my own practical experience, that it is decidedly best to lay down permanently after first of all growing a turf mainly composed of deep-rooting plants, and plants which leave much vegetable matter in the soil. For I have found in the case of alluvial flats containing rather heavy land that, after having laid down the land and left it in grass for about eight or ten years, we have, on again ploughing up and laying down, after a course of crops, had by far the most successful takes of grass that I have ever seen. There were two evident reasons for this favourable result. The first was that the soil was well permeated with vegetable matter, and the second that, being so, a thoroughly satisfactory and well aerated bed was provided for the springing of the seed, and the subsequent growth of the young plants. And in the cases previously alluded to, I am satisfied that a still better result would have been obtained had I, when first laying down the land in question, been acquainted with the deep-rooting chicory, burnet, and kidney vetch, and the advantage of using, from a vegetable-matter-creating point of view, a large amount of cocksfoot and yarrow. It may be urged that the process would be a costly and tedious one, and with the old system of laying down with a large proportion of ryegrass, which entailed a falling off of the pasture in the fourth year, this would have undoubtedly been the case; but, with our recent experience here, I have found that land of tough quality, and deficient in vegetable matter, may be loosened, ameliorated with vegetable matter, and deeply cultivated with the agency of roots in about three or four years; and then, after our usual four-course rotation of cereal and root crops, laid down to permanent pasture with satisfactory results. Having thus dwelt upon the importance of disintegrating the soil, and permeating it thoroughly with vegetable matter, before laying it down to permanent pasture, I now propose to allude to the equal,

or even greater, advantage of doing so in the case of land to be left in grass for five or more years, and which is to be again broken up for the winter support of the stock on the farm.

I have been told by a very intelligent gardener, who is practically acquainted with the great importance of soil disintegration through the agency of roots, that if he trenches land a foot deep, and takes from it a crop of parsnips, he finds, on taking up the crop, that the land immediately below the part dug is in finer physical condition than the cultivated land above. And this, of course, arises from the fact of the parsnip roots penetrating, and minutely sub-dividing, the soil, which, from its depth, has the advantage of being largely removed from the action of the weather. And, to give another illustration, we find the same thing in India when the forest is allowed to gradually extend itself into the adjacent grass land, and when the roots of the trees gradually permeate the land below the reach of the roots of the grass plants, and so turn the whole soil to a considerable depth into a beautifully cultivated subject. Or, to take yet another illustration, it may be mentioned that agriculturists in France, to improve certain arable lands, sow on them a mixture of gorse and grass (to be cut for hay) with a view of improving the depth and texture of the soil, which, after the lapse of a certain number of years, is again brought under the plough. Of all cultivating agencies, then, roots stand by far at the head, and it is by applying this principle to our arable lands that we shall at once manure, aerate, and cultivate them in the cheapest manner. All agriculturists recognise this in a general way; but, as regards the cultivation of our lands with the agency of deep-rooting forage plants, it can hardly be said to have been, practically speaking, recognised at all in this country. And I may go as far as to say that, till it is so, our agriculture will never be placed in the position of safety it ought to occupy. I was long ago certain of this, but

I never thought that I should be able to prove it to such an extent as I am now able to do; and, as the subject is of great importance, I propose to enter, with some degree of detail, into the particulars of the first experiments made by me as regards laying down poor and exhausted land, with the addition of various deep-rooting plants to the mixture of grasses and clovers suitable for such soils.

The fields operated on—the Outer Kaimrig, 22 acres, and the Inner Kaimrig, 25 acres—were two of those fields of which there are only too many examples in Scotland, and which never should have been enclosed from the hill and ploughed unless with the intention of at once laying them down to permanent pasture, or treating them on the same system as that previously recommended by me. But they had been managed, and probably for the last fifty years, on the same five-course system as the best lands of the farm, but without the advantages of the latter, for the land was so high and distant from the steading that no farm-yard manure was ever applied to it, and the only manure it ever got was just enough of artificials to grow the turnip crop. Everything, then, came down, and nothing went up except the ploughs, horses, and people, which were requisite every rotation to more and more thoroughly exhaust the soil, and, worse still, more and more impair its physical condition. What to do with such fields was indeed a problem, and one of them in particular reminds me of Arthur Young's description of some land he unfortunately embarked in, and of which he graphically wrote—"I know not what epithet to give this soil—sterility falls short of the idea—a hungry vitriolic gravel. I occupied for nine years the jaws of a wolf. It was calculated to swallow, without return, all that folly or imprudence could bestow on it." And the soil of my fields must have been nearly as bad, for one of them consisted to a considerable extent of a poor thin moory soil, while the other only contained a certain

proportion of fair hill soil, and to have attempted to treat them on the old system would certainly have been to occupy the jaws of a wolf or a crocodile. I then determined on laying them down to permanent pasture, and they were accordingly both laid down in 1890 with a thin seeding of oats. The poorer of the two, the Inner Kaimrig, a field of 25 acres, was sown as follows:—

	lbs.		lbs.
Cocksfoot	14	Golden Oat Grass	1
Tall Fescue	5	White Clover	4
Crested Dogstail	2	Alsike Clover	2
Hard Fescue	3	Perennial Red Clover	1
Smooth-stalked Meadow Grass	2	Yarrow	1
		Birdsfoot Trefoil	½

Total, 35½ lbs. per acre.

The adjacent field, the Outer Kaimrig, 22 acres, I resolved to experiment on, and the mixture used was as follows:—

	lbs.		lbs.
Cocksfoot	10	Ribgrass	1
Tall Fescue	3	Yellow Suckling Clover	1
Crested Dogstail	2	Kidney Vetch	1
Hard Fescue	3	Lucerne	2
Smooth-stalked Meadow Grass	2	Late-flowering Red Clover	2
		White Clover	3
Golden Oat Grass	1	Alsike Clover	1
Burnet	3	Yarrow	1
Chicory	1	Birdsfoot Trefoil	1
Parsley	1		

Total, 39 lbs. per acre.

Both fields were grazed with sheep. The Inner Kaimrig field showed great signs of inferiority to the Outer Kaimrig field, sown with the mixture which included the seeds of the deep-rooting plants, and so much so that, after a three years' trial in grass, I resolved to plough it up, and lay it down again with a much larger proportion of deep-rooting plants, of which,

in the meanwhile, from introducing them on other land in my occupation, I had formed a most favourable opinion. The Inner Kaimrig field was accordingly ploughed up at the end of 1893, when it was found, mainly, I believe, from the quantity of cocksfoot and yarrow used, that quite a thick sod had been formed. In 1894 the land was cropped with turnips, which was a fair crop, considering the poorness of the land. In 1895 the land was again laid down with a thin seeding of oats (which turned out a very fair crop), and the following seeds *:—

	lbs.		lbs.
Cocksfoot	6	Italian Ryegrass	4
Meadow Fescue	5	White Clover	2
Tall Fescue	4	Alsike Clover	2
Tall Oat-like Grass	3	Late-flowering Red Clover	2
Hard Fescue	2	Kidney Vetch	2½
Rough-stalked Meadow Grass	½	Chicory	2
Smooth-stalked do. do.	2	Burnet	8
Golden Oat Grass	½	Sheep's Parsley	1
		Yarrow	1

Total, 47½ lbs. per acre.

As the field was to be cut for hay, Italian ryegrass was added to the mixture. The land was so poor that

* If I now (1907) had to lay down this field, I would use the following improved mixture, as the experience of the last twelve years has shown me that a better mixture can be made without increasing the cost of the seeds used; indeed, the cost of this improved mixture will in most years be rather less than that of the original mixture.

Improved Inner Kaimrig Mixture.

	lbs.		lbs.
Cocksfoot	10	White Clover	2
Meadow Fescue	5	Alsike Clover	1
Tall Fescue	4	Late-flowering Red Clover	2
Tall Oat-like Grass	3	Kidney Vetch	2½
Hard Fescue	1	Chicory	3
Rough-stalked Meadow Grass	½	Burnet	8
Smooth do. do. do.	1	Sheep's Parsley	1
Golden Oat Grass	½	Yarrow	½
Italian Ryegrass	3		

Total, 48 lbs. per acre.

I had not thought of trying to take a crop of hay from it, but, as my factor wished to do so, I allowed him, as an experiment, to make the attempt. The result for such land was really astonishing, and surprised the various agriculturists who, by my suggestion, visited the field, for a crop of hay was grown which was as good as that produced on the best low-lying lands. There was no weighing machine on the farm, but from a careful estimation of the stacks, the crop was not less than two tons an acre, and the field yielded a fine aftermath. After such a crop of hay on such poor land, which had never been manured since it was enclosed from the hill some 70 years before, I expected that the field would afford poor grazing, but was agreeably surprised to find that an excellent account of its grazing capabilities was given by the shepherd and steward.

It will be observed that, in the case of the field from which the hay was taken, the field was cropped with turnips after being ploughed up, and the following year laid down again to grass with a crop, and was not put through our usual four-crop rotation—*i.e.*, a turnip crop, a cereal one, another turnip crop, and laying down again with a cereal crop; and this course was adopted because of the extreme poverty of the land. Indeed, in the case of such poor soil it is doubtful whether the land, when again laid down, should be laid down with a crop; but this is a point which will again be referred to when I come to weigh in a subsequent chapter, the various methods of laying down to grass.

In the year following the hay crop of two tons an acre, the field was grazed with sheep and lambs. And this year (1898) the field (much to my astonishment, after having yielded such a hay crop, and so much good grazing the year afterwards) has again exceeded my utmost expectations, showing that the manurial effects of the ploughed-up turf is still going on. And I say my utmost expectations, because, in the case of such

poor land, to which no manure had been added since the artificials supplied with the turnip crop, I certainly expected that the grass would have much declined in the third year.

The adjacent field (the Outer Kaimrig) of 22 acres did so well, in consequence of the addition of burnet, chicory, etc., that I had determined on leaving it in permanent pasture; but, moss having made its appearance, it was ploughed up at the end of 1895, and cropped with turnips, preparatory to being laid down to grass on the system previously recommended—*i.e.*, taking first a turnip crop, then oats, then turnips, and then laying down with a thin seeding of oats to lie for an indefinite number of years. On ploughing up the turf, it was found to be so thick and strong that I am now inclined to think that it would be better, in the case of land left more than four years in grass, to begin the rotation with rape. When this field, the Outer Kaimrig, was ploughed the second time no difficulty was experienced, as the land had become so ameliorated by the added vegetable matter of the first turf. We have found no difficulty in taking turnips out of grass in the case of other fields. For later information about the Outer Kaimrig field, *vide* Appendix III.

But I have found, from using chicory, burnet, kidney vetch, and a liberal supply of yarrow, that there are other attendant advantages besides that of disintegrating the soil and supplying it with vegetable matter, for all light land is, of course, very liable to suffer from drought, and all these plants resist drought to a wonderful degree. Of this fact I had a remarkable confirmation in 1895, in the case of a large flat field on the margin of a stream (called haugh in Scotland)—a field interspersed at intervals with gravel beds, the grasses in which, of course, are quickly burned up in periods of drought. In that year there was a very severe drought, and, therefore, an excellent opportunity for testing the value of these plants in dry weather. When the drought was at

its height, I, on June 17, 1895, carefully examined the field, and especially the shingly beds on it. On these the grasses and clovers were withered down to the ground, and the clover leaves crumbled in the hand as if they had been scorched by fire ; but the drought-resisting plants were green and sappy, though in various degrees. Chicory and burnet clearly stood the drought best, then came kidney vetch, and then yarrow. Of the lucerne plant I cannot speak so positively. Some were dried up and yellowish, while others looked fairly well. I was particularly struck with a plant of burnet. It was touching one of cocksfoot (which stands drought well as compared with other grasses), which was withered yellowish-white down to the ground, but the burnet was as green and fresh-looking as a thriving strawberry leaf. And I may add that, when on a visit to Oxfordshire the week following, when a bad drought there was at its worst, I found burnet, growing on high dry land, quite green and fresh-looking, though surrounded with grass, bleached as white as that on an Indian plain in the hot season.*

But besides their drought-resisting qualities, two of the plants recommended have valuable medicinal properties, for they keep sheep in healthier condition, and both burnet and yarrow are of especial value in enabling sheep to contend with diarrhœa, while the former is valuable in cases of rot in sheep. Some years ago, when there was much diarrhœa amongst our sheep, I asked a very experienced farmer, who occupied land contiguous to mine, to notice especially how far my flocks compared with his, and I found that I had a much smaller proportion of afflicted sheep and lambs.

* During the summer of 1898 we had a severe drought, which showed conspicuously the advantage of using drought-resisting plants. I this year observed, what had before escaped my notice, the great drought-resisting power of the late-flowering red clover, which is particularly to be recommended for light soils, and I am now inclined to place it, as a drought-resisting plant, on a level with chicory, burnet, and kidney vetch.

Another advantage was also found from using much cocksfoot and strong-rooting plants, and which is that the couch grasses were almost extinguished, and this, of course, cheapened the cost of cultivation when the land was again brought under plough. Lastly, it may be observed that from an experiment in a field on the low-lying land on this property, I have reason to surmise that chicory and burnet, if used in sufficient quantity (which they were not in my first experiments), are instrumental in lessening moss, or even of almost entirely preventing its appearance, though it is difficult to determine how much this effect is caused by the aeration of the soil which is effected by the strong and deep roots of these plants, or by their causing the ground to be more quickly and completely covered, or by both.

So far as I am personally concerned, then, I have solved the problem as regards cultivating poor lands without the aid of any manure, and have solved it to the extent of growing, on the poorest land, crops as good, and indeed, I may say, much better, than those commonly grown on the best land; and I have done this, too, after leaving the land only four years in grass, and on a system which is continually improving the fertility of the soil, and increasing the depth available for the roots of plants. In the Big Haugh field some drills of turnips were sown without any manure in 1901 and 1903, and answered so well that I sowed a whole field without any manure in 1904 (*vide* Appendix III.). The system, as the reader will have seen, is an extremely simple one. It consists of creating, with the agency of large-rooting and deep-rooting plants, a good sod, and then relying on it for the manurial (except the turnip manure) and physical conditions necessary for growing two green and two cereal crops, after which the land is again laid down to grass, and the creation of a good sod again commenced. But I must warn the reader, as I have elsewhere done, that this cannot be effected with

the aid of the grass mixtures commonly used in rotation husbandry, as with these from six to eight years would be required to form a sod, and even then that would be far inferior to the sod which can be produced in four, or even three, years, with the aid of the mixtures I have found to be most efficacious.

This question now naturally arises—Why should I have had to work out my own salvation at my own risk and cost? Why should I not have known exactly what to do when I first took over the farm alluded to? And why should farmers in Great Britain in general not know exactly what to do in order to cope best with the difficulties of these times, and how to do it in the cheapest manner which combines with it the utmost degree of efficiency? The answer to these questions simply is because of the negligence of our Government, for there cannot be the slightest doubt that had it had experimental farms and agricultural schools the principles I have laid down, and proved the success of, would long ago have been brought to the notice of our agriculturists and generally adopted. For, as we have seen, the farmers in Normandy, aided as they were by Government schools and farms, seem to have had no hesitation in at once altering their systems in accordance with the requirements of the times, and there can be no doubt that the same results would have occurred here had similar facilities existed for the diffusing of agricultural knowledge, and full and timely information as to all the world-wide causes which would necessitate a complete change of farming system.

But it may be urged that, as we have hitherto done fairly well without Government schools and farms, none are needed now. Such reasoning—and it is a too common course of reasoning—shows how dangerous it is to rely on the experience of the past for lessons for the future, for it is seldom that the whole conditions of the past are exactly repeated, and there is, therefore, always a great risk run of applying to a different set of

circumstances conclusions which were once fairly sound for circumstances only partially parallel. In former times no sudden change was required, and therefore the slow processes of improvement which resulted from the example of the most intelligent proprietors and agriculturists answered fairly well. But when a sudden change of front, owing to the wonderfully rapid increase of foreign competition, was required, the knowledge necessary for at once changing our system did not exist, and there was no machinery ready in the shape of agricultural schools and experimental farms for providing it; and the result is that while Normandy farmers, as we have seen, have at once been able to reorganize their farming system, and thrive accordingly, we have changed but little; and when we have changed in the direction of laying down land to grass, this has often been so badly done, and with so little discrimination, that a vast amount of preventable loss has occurred in all parts of these islands. And this loss has been largely increased owing to the fact that, from the want of proper means of instruction being at hand, the seedsmen themselves were as ignorant of the seeds they sold as were the people who bought them; and hence an enormous loss was inflicted on the purchasers of seeds, as we shall see in a future chapter. The so-called seedsmen were really not seedsmen at all, but merely shopkeepers who sold seeds, of which they either had no knowledge, or none worthy of the name. They ordered seeds from the large seed importers, who took, with little or no enquiry, seeds sent them from abroad, and passed them on, with all their weed seeds in addition.

In this connection I may observe that had such schools and farms existed an immense advantage would have been gained from the instruction they would have afforded, not only as regards fruit and vegetable growing, but also—and this is of even more importance still—as regards the means, now so largely employed abroad,

of preserving fruits and vegetables. And I know of no more marked instance of the evil results arising from the neglect of a civilized Government of the material interests of its people than has occurred in the case of our neglect of what other Governments have done in the way of agricultural education; for, while preserved fruits and vegetables are so largely used abroad, we have actually had, for the requirements of our Navy, to purchase preserved vegetables in France and Germany. My friend, Dr. Voelcker, has brought out an interesting article on this subject in the *Royal Agricultural Society's Journal*, but neither his article, able though it is, nor any number of articles, can be of any widely-spread practical value till the Government provides an adequate informative agency in each agricultural centre.

I may observe, lastly, that the spasmodic efforts which have been made by various County Councils, or which may be made, can never efficiently supply the agricultural requirements of the nation. For whatever efforts may be made by each County Council, paddling its own canoe, as each county does in the way of roads and other matters, will only lead to a number of all-over-the-shop experiments—fairly well-conducted, perhaps, in one county and badly in another, and leading to numerous conflicting conclusions. What, then, is obviously required is that groups of counties of closely similar conditions as to soils and climates should be marked out, and a farm and school established at some convenient centre in each group, and that all these institutions should be placed under an Agricultural Department, which should direct and control the various schools and farms throughout the country; and, in especial, keep the farmer fully informed, and up to date, as to all the agricultural conditions in the world. But is it not evident that it is only with the aid of education and world-wide information that our farmers will be in a position to alter and re-alter the direction of their efforts in accordance with the requirements of the times?

In the next chapter I propose going further into details as regards chicory and burnet, and preceding my remarks by some observations as to Arthur Young and his writings, with special reference to his great unpublished and almost unknown work, which now reposes on the shelves of the MSS. Department of the British Museum.

CHAPTER IV.

ARTHUR YOUNG, AND SOME OF HIS AGRICULTURAL EXPERIENCES WITH REFERENCE TO CHICORY AND BURNET, AND THE PRESERVATION OF GRASS FOR WINTER AND SPRING USE.

ARTHUR YOUNG, the widely-known writer on agriculture and social economy, is described by his friend, Dr. Paris, in the memoir written by him, and which follows the prefaces to Young's great unpublished work, "The Elements and Practice of Agriculture," as being descended from a respectable family who had resided on their estate at Bradfield Combust, near Bury St. Edmunds, Suffolk, for more than 200 years. He was born September 7th, 1741, and as a boy was recognised by his early friends and preceptors as a lad of very superior talents and indefatigable industry, and of the correctness of this recognition he afterwards gave ample proof. In 1758 he was placed in a mercantile house, but showed no tact for commercial pursuits, and he early evinced what his natural bent was by publishing, when at seventeen years of age, a pamphlet on "The War in North America," and also by beginning a periodical work entitled "The Universal Museum." After his father's death, in 1759, his mother gave him the direction of Bradfield Hall, and in 1767 he began to farm on his own account in Essex. In 1770 he published "A Course of Experimental Agriculture," and between 1768 and 1770 his "Tour Through the Southern Counties of England and Wales," his "Six Months' Tour Through the North of England," and his "Farmers' Tour Through the East of England," books which were favourably received, and translated into

most continental languages. He published, besides, the "Farmer's Letter to the People of England," the "Farmer's Calendar," and in 1774 his "Political Arithmetic." In 1784 he began the publication of the "Annals of Agriculture," which was continued for forty-five volumes. His "Tour in Ireland" and his "Travels in France," however, are the works by which he is now best remembered. In 1792 he was appointed secretary of the Board of Agriculture, which was then just formed under the presidency of Sir John Sinclair, and in this capacity his services were of the greatest value in the preparation of the agricultural surveys of the English counties. Young's works have appeared in almost every language in Europe, and were translated into Russian by the order of the Empress Catherine, and they seem to have been almost more appreciated abroad than they were in England. His latter years were attended with distressing bodily afflictions—blindness, and a painful internal malady. He died, we are told by Dr. Paris, on the 12th of April, 1820, at his house in Sackville Street, London, "after taking a glass of lemonade, and expressing himself easy and satisfied." Young was succeeded by his daughter, who died in 1851, and she was succeeded by her nephew, the grandson of Arthur Young, who died at Bradfield, January, 1896, and the Young family is now extinct, after a landed existence there of about 350 years.

Young's latter years seem to have been largely occupied in composing his great unpublished work, entitled "The Elements and Practice of Agriculture," the existence of which few people can be aware of, if I may judge by the fact that no reference to it has been made by the writer on Young in the "Encyclopædia Britannica," from which, I may add, I have taken the list of works given above. Last July I accidentally heard of his work, which had been presented to the British Museum by the widow of Arthur Young's grandson, and at once went to look at it, in the hope

that I should find something of value with reference to the subject I am now writing on. I was asked by one of the polite officials in the MSS. Department if I should like to see the whole work. I replied in the affirmative, expecting to see two or three volumes at the most. After some delay the door was opened, and there was wheeled noiselessly into the room a kind of perambulator on four Indiarubber-tyred wheels, on which were ten very large volumes of MSS. written on foolscap of very large size, and none of which, I think, contained less than 500 pages, while several contained more than 1100. These enormous volumes, though entitled "The Elements and Practice of Agriculture," really seem to relate to every branch of rural economy, down to the management of bees, the transporting of live fish alive, and the castrating of fish, a practice which seemed to be not uncommon a century ago, and a notice of which I have read in the *Scots' Magazine*, which runs from 1739. It was, no doubt, on this great work that he thought his reputation would most surely rest, and, considering that its very existence can hardly be said to be known, it is difficult to read Arthur Young's preface to it without a feeling of melancholy. "This work," he says, "which I now presume to offer to the public, has been founded on the basis of fifty years' experience, much of the labour of more than thirty years, and travelling to the extent of more than 20,000 miles. It was not originally undertaken with the design of publication, but to form a collection of all those passages which I met with in the perusal of books for my own private use." Shortly after Arthur Young's death an attempt was made to bring out what has been well called his life's work, and it was accordingly submitted to publishers in London; but they were all deterred from undertaking the publication, owing to the great size of the book and the consequent risk of publishing it. A few years later Sir John Sinclair, who was anxious that the work should not be lost sight of to the agricultural world, asked to have it

sent to Scotland, believing that Edinburgh publishers would perhaps undertake what their London brethren had declined; but no success attended this attempt, and the MSS. were returned to Bradfield, then occupied by Arthur Young's daughter.

Miss Young died in 1851, having appointed as her executor a Mr. de St. Croix, who then placed the MSS. in the hands of his brother Walpole to copy and condense, so that they might be bound and preserved; hence the ten large volumes to which I have alluded, the full title of which is "The Elements and Practice of Agriculture, by Arthur Young, F.R.S., and secretary to the Board of Agriculture, edited from the original MSS. by Walpole de St. Croix, from 1852 to '55." It may be well to mention that the MSS. have been copied in a clear handwriting, and that to each volume there is a table of contents, so that the work may be easily consulted. The original MSS. are also in the British Museum, and one of the officials called my attention to the fact that certain passages had been deleted; but I find, on enquiry, that it is impossible to ascertain whether the deletions were made by the editor or by Arthur Young. They do not seem to be very numerous, if I may judge from a slight inspection I made of one of the bundles of the original MSS. In the Editor's preface it is stated that "the present work, as its title would imply, is not designed to be the practice of Agriculture alone of Arthur Young, but rather a compendium of husbandry from its first dawn to the period of his death in 1819 (which date, I may remark in passing, is a year earlier than that elsewhere given); and in it there are many quotations from, and references to, continental writers on agriculture. As my object was to take notes of points relating to grasses and other forage plants, I confined my close attention to them exclusively, and now propose to give some account of my gleanings from the volumes left by Arthur Young, and shall begin by going at some length into his

experiences as regards two important forage plants, chicory and burnet, as to both of which I have had, as the reader has seen, most favourable experience on this property.

Chicory *(Cichorium intybus)* was first cultivated in England by Arthur Young. In 1787 he found it not uncommon in France, and applied to considerable profit by that intelligent husbandman, Mons. Cretté. The produce was so great, and exceeding that of any other plant known, that Young determined to introduce it into England. "Of all the grasses,"* he says, "it is perhaps the most universal grower if managed and applied with attention." It was probably first cultivated by the Italians. In 1780 it was remarked by a French writer that sheep are very fond of it. It is indigenous everywhere in Lombardy, and is found in the watered meadows freely eaten by every sort of cattle, especially by cows when it is young, and it affords much milk.

Mons. Cretté sows in March, and mows once in the same year. His practice was to dung the land in winter. In the following year he cut thrice, and parts of the land four times. Mons. Cretté used it much in soiling, and with great success, for horses, cows, young cattle, and calves. It is greedily eaten by all, and gives good cream and butter. It is not hurt by drought. He used 20 lbs. of seed for rather less than an English acre. No meadows, natural or artificial, can compare with chicory. Lucerne gives only $4\frac{1}{2}$ tons of hay per English acre, while chicory will give 11 tons. The dry fodder is well eaten, but it is much better given green. Such were Mons. Cretté's experiences of chicory.

In 1788 Arthur Young sowed 10 lbs. of seed over 5 acres of barley on a good strong wet loam among clover, trefoil, rib, and burnet, and found that the chicory was always eaten by sheep, cows, and fattening

* The old writers, and farmers in general now, *always* use the term grasses for all plants used with grass mixtures.

bullocks as close to the ground as any other plant in the field. In 1788 he sowed it in drills a foot apart. It produced in green weight in four years 119 tons, or near 30 tons per acre per annum. He had seen chicory flourishing well on clay, loam, sand, chalk, and peat, and had known it sown upon the very poorest spots of poor farms with such success as to prove indubitably the great importance of the plant. If fed off with sheep it would greatly improve the succeeding corn crops. He had known it in the North of Scotland to bear cutting six times in the summer. Pigs are remarkably fond of it. "On all poor lands," Arthur Young writes, "it is of the highest consequence, having no rival. On the very worst soils it is beneficial for sheep, and I may venture to assert that on such a full stock of sheep cannot be kept without it." It succeeds well, he says, sown with barley, or oats, or indeed any other crop. On middling loam he sowed 12 lbs. per acre broadcast, on poor soils 15 or 16 lbs., but in drills at 9 inches or a foot apart he found 10 lbs. to be enough. If sown in drills at a foot apart horse-hoeing he found to be of great value, and this rendered the plant very luxuriant. Chicory he considered to be too succulent a plant to be made into hay on the average of seasons in this humid climate.

Horses, and hard-worked horses, did well soiled with chicory, and without either hay or corn. It produced no ill effect on milk, cream, or butter. In 1792 a Mr. Dunn fed horses, cows, and hogs with it, and found that the cows' milk was greatly increased. Chicory should be cut four times instead of three in the season to prevent stalks running up.

In 1790 a Mr. Martin said that in the drought of the present season he has nothing on his farm that will keep half the stock that his chicory will, though it is four years old. He fed it with sheep, and highly approved of it. The Duke of Bedford expressed a high opinion of chicory. In August, 1796, 12 lbs. chicory and 5 lbs. trefoil

were sown on a fallow, and grazed about Michaelmas for a month with five sheep an acre. In 1797 it kept six sheep an acre from the second week in April until Michaelmas. On 4½ acres, which were sown broadcast with chicory, ten sheep an acre were kept the first year, 1796, from first week in April to July 22, and then seven per acre to end of October. In 1797 it kept seven sheep per acre, and they had done well. Mr. May, near Ipswich, found chicory the best plant for sheep feed on poor dry soils, and that it did not suffer from dry weather like sainfoin or burnet; and he observed it to grow 7 inches in three weeks, while the two latter plants, on the same soil, in the same field, as near together as possible, grew no more than 4 inches. Numerous evidences were given by Arthur Young to prove that the produce of chicory is at least equal to that of any known plant in this climate. It remains many years in the ground. From his experiments, 62 tons 18 cwt. of the green produce was cut in a year. "It will yield a profitable support," he says, "for sheep when the more common plants have almost entirely failed." Chicory hay is as readily eaten by live stock as any other. In the South of Scotland clover falls off so much in the second, and still more in the third, year, that a farmer sowed on a large scale a mixture of chicory, and the plants kept the ground so well that he was disposed to extend the cultivation, but he was deterred by the price of the seed. Chicory, he further states, is difficult to eradicate* when ploughing up, but in no proportion that ought to render it any objection to the culture. With reference to the duration of chicory,† he mentions that in 1790 12 acres

* This is contrary to our experience at Clifton-on-Bowmont.

† In 1893 the Haugh, 28 acres, was laid down, and in the mixture were 2 lbs. each of chicory and kidney vetch, and 3 lbs. burnet. The field was ploughed at the end of 1900, and turnips taken in 1901. The turnips were a fine crop, and the land was very clean, though no weeds were taken off. From the fence being shifted on the bank of the Bowmont a narrow strip next the fence was left unploughed. This

were sown with a mixture of plants, amongst which were chicory and burnet, and that in 1800 much chicory was visible. Arthur Young gives many evidences of its suitability for sheep. Finally, he sums up his reasons for advocating the use of this plant as follows :—

1. The greatness of its produce for soiling on good land.
2. Its yielding so amply in feeding sheep on all soils.
3. Its being remarkably applicable in the very poorest and most barren chalks and sands.
4. Its forming a most profitable change on all lands upon which clover fails from too often repetition.

Advantages and Disadvantages of Chicory. — As regards the hay crop the advantages of chicory are—(1) That it effectually holds up the crop, and this not only increases its bulk, but favours the growth of the smaller grasses and other plants, and also small plants which have sprung later in the season; that (2) when the weather is favourable it quickens the winning of the hay, as the stalks ventilate the cocks; and that (3) the stumps of the flowering stems keep the grass off the ground when the cut grass is in swathe, or in cock. This favours ventilation, and the grass underneath the cocks.

The disadvantages of chicory, as regards hay, are that, if the weather is wet, it retards the winning of the hay, as it holds much water. Another disadvantage is that hay with chicory in it requires to be used the first year. If kept over a year it becomes dusty, and is therefore unsuitable for stock, but there is no reason to suppose that it is unsuitable for stock and farm horses if used during the first year, nor do I know that it is unsuitable for horses in fast work—though I

showed in 1901 a fair proportion of burnet, chicory, and kidney vetch. Two acres of this field were railed off, and let to a blacksmith for his cow. I particularly inquired whether any effect on the quantity and quality of the milk had been produced by the chicory and burnet, etc. No effects were perceived, but the cow certainly gained in condition from the pasture, and became distinctly fatter.

should not recommend it—but this is a point that requires investigation. In the Bank field we found that by stocking in spring from the first week in April to the 20th May, eating the pasture quite bare, and then shutting up the field for hay, the chicory plant was so far suppressed that no seeding stems appeared; in fact, the plant was so suppressed as not to cause any objection as regards the hay crop.

The advantages of chicory in pasture are very great, and there are no disadvantages. The root goes straight down into the soil (in five months I have traced it to 22 inches, and in fifteen months to about 30 inches or more), and the leaves go straight up. The plant therefore neither robs the surface soil nor interferes with the plants in its neighbourhood, which flourish right up to the stems of the chicory. All stock are fond of the plant, and my keeper informs me that hares eat it more readily than any other plant in the pasture. It yields a large supply of food. It is evident that with such plants as chicory and burnet the available area of soil must be very largely increased, and their use in a field is, practically speaking, an absolute addition to its acreage. (Later information respecting chicory will be found in Chapter VI. and Appendix III.)

Let us now turn to another plant, which, from its deep-rooting, drought-resisting, and disease-preventive qualities, for sheep is of evident importance, and see what Arthur Young has to tell us about it.

Burnet *(Poterium sanguisorba)*, we are told by Young, will do on any land, but it thrives best on that which is dry. It is more to be recommended on a sheep walk, and is not only good for spring feed, but as a summer pasture. For the latter it should be kept constantly pared down close, in which management it grows very fast. An experiment by Mr. Anderson is quoted, which shows that on February 14th it was 3 inches high, and it was grazed at intervals every month up to September 29th, when the total growth was 72 inches.

Sheep are very fond of it. It is early in spring, but not so early as lucerne. Its principal use is for a sheep walk, and especially on poor hungry soils. No farmer should lay down for a sheep walk, or for a few years, without sowing a large portion of burnet. Arthur Young did not think the plant valuable for hay. It is spontaneous, he says, in the best spots of many of the finest meadows in England. Burnet, when in mixture, is eaten as close as any other plant. Half a bushel (burnet weighs about 26 lbs. per bushel) should be sown in mixture with either trefoil or ryegrass, or with other grasses, for permanent pasture. If sown by itself, one bushel should be used, and it should always be sown broadcast, though, I may observe, he gives no reason for doing so. Burnet is ready for sheep at the beginning of March, and is throughout the year of considerable value. It is not only a preservative against rot, but a cure for it, if only in the beginning of its progress. Cows eat burnet freely, if not old and sticky, and it gives butter an agreeable flavour. Young mentions that burnet was recommended by Worbage in 1675, especially for cows, as it gives the best butter and cheese. There are large tracts of the finest parts of the Southdowns upon which burnet forms half the indigenous pasture. In general, all cattle eat it readily when young, and to profit, but not when it is in bent. It is very advantageous for sheep in general. Anderson is again quoted by Young as follows:—"I have put sheep that scoured into a burnet field, and they have soon been visibly benefited. I would earnestly recommend to all farmers to intersperse some of it in every field sown for permanent pasture." One acre of burnet was sown on a part of a field the rest of which was turnips, and the following March fed with sheep, who preferred the burnet, and the acre was thought equal in consumption to any acre of the turnips. It was observed in Staffordshire that as a meadow grass it preserves the hay from over-heating in the stack. Hay of meadows which contain a considerable portion of

burnet comes out of a fine green colour, while other hay, equally well made, but without this plant, overheats, and comes out quite brown.

The anonymous author of a book on the improved culture of the three principal grasses:—lucerne, sainfoin, and burnet (G. Robinson, Paternoster Row, London, 1775), has much to say in favour of burnet. It may be sown, he says, from February to August or September, a fact of great value, as, in the event of the turnip crop failing, the land may be sown with burnet, which will give good feed in the early spring months, when it will be found that an acre of burnet is equal to one of turnips. The writer notices a curious circumstance connected with this plant, namely, that though it grows well in all light lands, it acquires from some lands a peculiar quality which makes it so unpalatable to cattle that they will not eat it. The writer, therefore, recommends that a trial on a small scale should be made if the plant is to be extensively cultivated. The author mentions the drought-resisting power of burnet, and shows that it continues to grow while other pastures are burnt up. Cows are fond of it, and it much increases the quantity and richness of milk and cream. He notices the curative value of it in the case of sheep afflicted with rot. In one case given where the land was gravelly and poor, burnet seed was sown with buckwheat, and some with summer vetches or tares; that sown with the buckwheat grew well, and after the buckwheat was mown, it spread and stood the winter very well. The seed sown with the vetches grew well, but was in some parts overshadowed by them. Burnet is an evergreen which resists cold, heat, and drought better than any other fodder plant, and is ready for use at all times of year, winter as well as summer. Its great value is in March, April, and part of May, when winter food is exhausted, and pastures insufficiently available. If not fed down too late in the autumn, but allowed to rise to half a foot or more, it will lose nothing of this in

winter, but will continue fresh, and also advance in its growth more or less according to the weather, and then in March and April the farmer will find himself with a good supply of food for horses, black cattle, and sheep. Burnet may be mown once or twice in the season for hay, but the author does not advise mowing when it is desirable to use the plant for grazing. The author recommends cutting the burnet in spring and feeding it to cattle in the house, or farmyard. Altogether much attention seems to have been paid to the valuable qualities of this plant, and the circumstances of these times are such that it would seem to be as valuable for them, as it evidently was to farmers in the year 1775. (*Vide* also Appendix III.)

I now turn to a point which was evidently of great importance in Young's times, and which, in consequence of grain growing having become unprofitable, has again become of great consequence, for the expensive turnip crop is not a crop that pays of itself, but is largely of value because of the grain crop that follows. If, then, grain is low in price, it is of obvious importance to replace the turnip crop as far as we can by some cheaper crop that will aid us in carrying our flocks through the winter and spring, and, as an additional reason for so doing, I may point to the well-known fact that turnips, when used exclusively, are an unsuitable food for sheep, as they are productive of disease—so much so that it is almost proverbial amongst shepherds, who all know that the more turnips we have the more sheep disease. And I may mention that when there was once a great failure in the turnip crop in this neighbourhood the sheep never did so well. I met with a remarkable instance of the danger of using turnips freely in the case of a farmer to whom I let a farm which had for some years been in my own hands. He complained to me that he had met with a great loss amongst his sheep, and yet when the farm was in my hands the death-rate had been very low, and, in going

into the subject, I found that it had arisen evidently from his changing his flock at the end of autumn to an exclusive diet of turnips. So that by turning our attention to other food for winter and spring I feel sure that we shall not only feed our flocks much more cheaply, but keep them in far healthier condition. I now proceed to quote Young's experiences of the value of what in his time was called rouen—or aftermath saved for spring use.

Young speaks highly of this practice, and "scarcely knew a person who tried it that ever gave it up." He had had twenty-five years' experience of its value. Writing in 1771, he says that it was a common practice in Dorsetshire, where the flockmasters placed their great dependence upon it. In 1776 he found that Mr. Maurice, in Shropshire, kept every year 30 acres for the support of his cows and sheep till February. Young found the system in practice in Suffolk. By Mr. Green's account in 1785 he kept the aftermath of some of his meadows for his dairy of twenty cows, and also for sheep and lambs, till his cabbages are done in March, never stocking the ground from mowing till that time. In a letter from a Dr. Parry we are told that he considers rouen to be "a cheap and valuable resource, which never fails except when it is covered with snow. Last year my shepherd was fully convinced that four acres of very indifferent upland rouen given to my ewes and lambs saved at least 3 tons of hay. Rouen supplies a sort of intermediate food between the dry and the green." The custom was pursued in Lancashire and Leicestershire by some of the best farmers, who asserted it to be the best and most certain spring food yet known. The autumnal and spring shoots mix, and furnish together more nutritious food than either taken separately. A pasture thus preserved is depended upon as the sheet anchor in preference to turnips, cabbages, or any other species whatever of what is called spring food. This kept grass gives more milk than turnips. Where

turnips fail, it is of immense value. A shilling spent in rouen goes as far as a guinea spent in turnips. My sheep, writes Arthur Young, in consequence of this aid, have not known a hungry belly in March and April. An acre of rouen is more valuable than most acres of turnips, which had suffered from the summer drought.

As an experiment, he put 22 ewes in 7 acres in one field, and 10 hogg rams in 3 acres of another, and these were kept from November to May without any other food, and no sheep on my farm did better. This was above three per acre, and for two months the former had their lambs at their side. I had rouen on the better part of my farm, apparently of near double the value.

The winter of 1794-95 was uncommonly severe, frost being of the hardest and longest ever known. His experience under these circumstances was that rouen was as safely to be relied on as in the milder winters during which it was tried. Young complains of turnips as being expensive and liable to be injured by frost, and he might have added that, unless unusual precautions are taken, sheep swallow grit and earth with them, which are both injurious.* The Earl of Exeter, we are told, sells all his turnips to his neighbours to be fed with sheep, and relies on his rouen, and has known no redwater, or other distemper, in his flock since he has adopted this practice. In his paper on the subject, Arthur Young gives numerous evidences of the value of rouen. In Tweeddale, on the sheep farms, part of the pasture is hained (preserved), and also in other parts of Scotland. Mr. Young says that he has depended upon it principally for the support of 200 sheep. The grass is much more early and productive in spring if, after mowing, no stock is turned in till spring. The dry

* A tenant farmer once took one of my grass parks, and sent in some prime hoggs, and some of them sickened and died My shepherd examined the stomach of one of them, and found grit in it, which had been swallowed when eating turnips which had not been sufficiently cleaned.

herbage shelters the young grass shoots in spring, and thus promotes their growth. Rouen was also adopted in Herefordshire. A Mr. Knight is quoted as observing that, if leaves are eaten off shortly after mowing, the roots are deprived of their nourishment, and the plants consequently vegetate weakly in the ensuing spring. Aftermath left to rot on the ground is a good preparation for the next crop of hay.

But in one part of the country the practice of saving growing grass for future use was much further extended, and Arthur Young, under the heading of "fog," observes that it is a term given in South Wales to the growth of the whole year kept till the ensuing winter and spring, a practice commonly found nowhere else. On dry sound land that will not poach, the whole crop of grass is kept in Cardigan without being mown or fed; stock of all sorts fed in depth of winter without any other food, and always in excellent order. It kills moss, and much improves the pastures; nor will an acre of the best hay support so much cattle as one acre of fog. The grass is much improved by the quantity of seeds that fall.

I now turn to Young's experience as to laying down land to grass. There is much said in favour of sowing grass with rape, to be fed off by sheep. In Yorkshire Colonel Vavasour laid down with buckwheat sown in the end of June, and harvested end of September, and this plan turned out to be very successful. At Felthorpe, in Norfolk, buckwheat was considered superior to any other crop in which to sow grass seeds. It affords good shelter, and, being late sown, gives a good opportunity for destroying weeds. Young laid down a field to grass (chiefly burnet) in 1769, which did very well, though the buckwheat was a very great crop—49 bushels an acre. Buckwheat he considered the best crop with which to lay down, because it was not exhaustive sown thinly, and yet from branching, and size of leaf, joins so close at the top that the young grasses have plenty of

room; they are quite sheltered from the sun in a drought, and, being sown so late as June, and even part of July, time for much tillage is afforded. Clover does well with it. Young records that an agriculturist (Dalton) had sown grass seeds with beans, which were preceded by barley, and which again was preceded by turnips, and the results were so successful that he preferred this to all other methods. In order to note the advantages of sowing grass seeds with oats as against doing so with wheat, Young on one occasion sowed 10 acres with 10 lbs. of chicory and 4 or 5 bushels of cocksfoot per acre. Five acres were sown with wheat and the rest with oats, and he found that the cocksfoot did much better with the wheat. He speaks highly in favour of sowing up land with wheat in the beginning of September. He quotes an agriculturist (Goring) who "once sowed grass seeds amongst turnips in the spring, and the sheep trod them in with their feet as they fed off the turnips. No corn was sown with them, and they flourished beyond any other." After quoting other opinions, Young thus concludes his section on laying down to grass:—

"Upon the whole of these most valuable articles of intelligence, and combining them with the result of my own extensive experience, I am decidedly of opinion that the best method is to sow the seeds alone in August; that the next best method is to sow them with buckwheat * in July; after these I should prefer rape in August on soils not apt to bind with treading; then comes the sowing with wheat early in September, and the last and worst method is to sow them with spring corn." (*Vide* p. 62.)

As regards the subsequent management of the pasture, Young's remarks show that there were great differences

* Young elsewhere praises buckwheat highly as an ameliorating crop, and one which increases the production of wheat. It deserves more attention than it has received It takes little out of the soil, and he quotes Tusser as observing that "it is to the land a comfort or muck." It is good for fattening swine and poultry, and as food for horses.

of opinion as to the mowing or grazing the first year. He mentions that Sir Charles Middleton hays the first year, and uses aftermath for fattening sheep and lambs, giving some oilcake, and folding off as for turnips. Another writer quoted says that nothing but having a good coat of dung to put on before winter can justify mowing.

As I notice in the *Field* of Sept. 12th, 1896, attention has been called to the value of loppings of trees as food for stock, I may mention that Arthur Young has a section on "Browsing," and gives many instances of the practice of cutting faggots of branches in full leaf and preserving them for winter use. Fir branches were used in this way in conjunction with hay. The freshly-cut branches were strewed about the field. After the sheep had picked off the green matter the wood was then used for firing. Elm branches were considered to be the best, and then poplar. Oak branches were considered to be good for this purpose. Young observes that a great saving of hay was effected by this practice.

I have now, I think, quoted from Arthur Young's great work most of those points which seem to me to be useful and interesting, but I cannot conclude the chapter without expressing my admiration of the wonderful combination of qualities he possessed, and which enabled him, and justly so, not only to impress and influence his own countrymen, but also all the most civilized peoples of Europe. Such a union of zeal, indefatigable industry, ability, perseverance, and undaunted courage it is indeed very difficult to find united in any man. One instance of the last I cannot help quoting from Dr. Paris' Memoir (previously alluded to), in which we are told that "in his second journey to France he set out alone, but he had not proceeded more than 100 miles when his mare fell blind; not, however, being discouraged by this incident, he travelled with her 1700 miles, and brought her safe back to Bradfield." But, besides the strength

of character shown by the instance quoted, he evinced the greatest candour of mind in chronicling his own mistakes, and severely animadverting on them, which he sometimes does to an amusing extent. Altogether, he leaves on the mind a most agreeable impression, and a feeling of confidence that in his various writings he has accurately and fully recorded the agricultural experiences of his times.

CHAPTER V.

LAYING DOWN LAND TO GRASS, AND THE TREATMENT OF THE PASTURE.

AS Byron has well said, there is nothing so difficult in poesie as a beginning, except perhaps an ending, a remark which applies to many subjects, and I confess I am rather at a loss to know how far to go back in my treatment of this subject. Those who wrote on agriculture long ago, and undertakings connected with it, generally seemed to aim at a remote start, and we accordingly find that the writer of the article on agriculture in "The Complete Farmer, or a General Dictionary of Husbandry in all its Branches," the fourth edition of which was published in 1793, claims for the art of agriculture "the precedence of all others in point of antiquity, it having been the sole employment of our first parents in the delightful garden of Eden," and continues by observing that "Adam instructed his children in this most necessary art, both by example and precept." And it may also be noted that Mr. William (afterwards Sir William) Dugdale went back a point further in his book on "Draining and Imbanking"—work which he traces to a Divine origin, seeing that—and he supports his statement by quotations from Genesis—the Creator began with these most necessary undertakings, having found that nothing could be done with the world till it had, first of all, been drained and embanked. While another writer, when alluding to *Poa aquatica* (reed, or sweet water meadow grass), has suggested that, from its feeding qualities, it was probably on this grass that Nebuchadnezzar subsisted when he was turned into the wilder-

ness, and so carries back his observations on this plant to a remote probable use of it. I think, however, that the reader will rest satisfied with my having, in the preceding chapter, alluded to some of the works of those who lived in the last century, and begin the subject of laying down land to grass by referring to an interesting paper which appears in the appendix of Dr. Keith's "Agriculture of Aberdeenshire."* But before doing so, it may be interesting and useful to allude to some opinions as regards ryegrass which Dr. Keith quotes from Dr. Anderson's "Original Report of Agriculture in Aberdeenshire."

After remarking on the value of ryegrass† in the case of rich lands, Dr. Anderson observes that :—

"Upon poor soils it is perhaps one of the worst grasses yet known. Its leaves there are not more abundant than those of dogstail grass; and so dry and rigid that cattle are not fond of it. Its stalks spire forth very early, and, being unmixed with leaves, they are tough as wires, so as to be disrelished by all beasts; and are all allowed to get into seed, when they become brown and sapless, and good for nothing. On poor fields no practice can be so bad as that of sowing ryegrass. It extirpates all other grasses, and this is worse than any of them."

Dr. Horne, in his "Principles of Agriculture and Vegetation," Edinburgh, 1757, p. 65, says :—

"Ryegrass is especially injurious from its effect in binding together, and so hardening the soil."

It is not a little remarkable that this grass, which, for poor lands at least, was so justly condemned in former times, should be a grass still so much used in Scotland on poor lands; but this, of course, is to be attributed to the ignorance of the farmers as regards other and more suitable grasses, and Dr. Keith, though he does

* "A General View of the Agriculture of Aberdeenshire," by George Skene Keith, D.D., Aberdeen. 1811.

† The value of ryegrass is further discussed in Chapter VI.

not, as I strongly do, recommend the starting of Government experimental farms, goes far in this direction when he suggests—

"That a publication which might, by the Board of Agriculture, be rendered both a cheap and useful one, is much wanted, not only in this county, but in every county in Great Britain. This is a book, neither voluminous nor couched in learned phrases, which would point out all the bad practices in the different districts which ought to be abandoned and avoided, and all those good practices in husbandry which ought to be universally known and generally imitated."

Let us now turn to the short paper to which I have alluded, and which, we are informed by Keith, was contributed by a gentleman of Aberdeenshire, who did not wish his name to be made known.

The paper in question is entitled "Observations on British Grasses," and, though only consisting of six pages, contains as full and exact an account of the principles by which we should be guided when laying down land to grass as could be desired. He begins by animadverting on the poor qualities of ryegrass, and then describes the results which follow from its use when laying down light lands to grass. He shows how, in the second and third year, the clovers and ryegrasses decline; how the blanks are filled with weeds and bad grasses; and how, at last, the whole land is covered with a thick, but coarse, herbage; and how any attempt to arrest this natural course of things by top dressing will only end in disappointment and loss. He then proceeds to observe that in all such cases there is a deterioration of the soil, which gradually consolidates, as is evidenced by the flattening of the ridges and the firm texture of the soil when turned up by the plough. This solidity, he observes, is very different from the tenacity of clay, and resembles more that which is observable in flower pots whose earth has been kept too long unchanged. He then dwells on the disappearance of vegetable matter from the soil (the

evils of which I have previously remarked on), and comes to the conclusion that such light lands, if worthy of cultivation at all, should either be brought under the plough more frequently, and refreshed with manure, or laid down with some of the hardiest grasses. He then enumerates various grasses which, in his opinion, would be suitable for such soils; but I do not propose to dwell upon the kinds mentioned, as my object is to call attention to the fact that the principle of putting down a mixture of grasses suitable to the soil, and without any admixture of ryegrass, was recognised so many years ago, and that attention was also called to the decline of vegetable matter in the land, to the consequent consolidation of the soil, and its being turned into a bad physical medium, or a bad nest for the plant. But why should this consolidation of the soil not have been prevented by putting down a mixture of plants which would at once permeate it to a great depth, and furnish it with abundance of vegetable matter? It is singular that a writer so evidently intelligent as the author of the paper should have failed to point to the obvious solution of the difficulty, and it is also remarkable that Arthur Young, though he used a mixture calculated to effect this purpose when he recommends chicory, burnet, and the free use of cocksfoot and yarrow, should have failed to point out their great value in disintegrating and aerating the soil, and filling it with vegetable padding. After carefully examining his work, from which I have taken so many extracts, I can find no allusion to the important physical effects arising from the use of these plants. But the reader has now heard probably enough of this branch of my subject—enough, I trust, to impress him with those principles which should guide him in the selection of plants, either for temporary or permanent pastures—namely, that a selection should be made which will at once provide the most food for stock, keep it in healthy condition, and maintain a good physical condition of

soil. I now pass to a consideration of the various methods of laying down land to permanent pasture.

My readers will remember that in the previous chapter I have given, from Arthur Young's great work, his own opinion as to the various methods for laying down land to grass, and also those of other agriculturists whose systems are recorded by him. My present system here, after the trial of several different methods, is to lay down in spring with a light seeding of barley or oats*—a system which I have found to answer well, both as regards grass and the requirements of the farm, and which, I may observe, was condemned by Arthur Young as being the worst; while the late Mr. John Wilson, Berwickshire, for years adopted a system, to which I shall afterwards allude, which is very different from any practised elsewhere, as far as I can learn. After carefully weighing the merits of the various systems, I have come to the conclusion that, in consequence of the variety in both soil and climate, and the varying circumstances and requirements of the farmer, no general rule can be laid down as to which is the best method, and that this should vary according to the circumstances of each particular locality. And here I am left to grope in the dark, for, from the non-existence of the Government experimental farms which ought to exist in each locality, there is really no means

* With a seeding of slightly under a bushel of barley we have obtained a heavy crop—or, at least, a very good one; and that, too, without injuring the grass, which would have suffered had the crop been obtained with the aid of a full-seeding of barley. In the first case a number of barley shoots are thrown out from each stem, and this has the effect of letting more light into the ground, while, in the event of the crop being laid, the shoots on the upper side of the prostrate stem remain more or less erect, and certainly raised above the ground, and thus do not lie on the grass. A heavy crop of barley from a full seeding gives many stems, with few shoots to each, and both stems and shoots are of a weak character from crowding; hence, if laid, the crop goes down like a thatch on the young grass, and, in any case, the young grass plants are overshadowed, and thus weakened in character.

of writing on the subject in a satisfactory manner; in other words, there is no means of proving what courses are most suitable for the varying climates of these islands. For instance, after studying the methods recommended by Arthur Young, I am strongly inclined to agree with him in thinking that to lay down with buckwheat, after taking a crop of winter vetches, would probably be the best plan; but though this would evidently be, from Young's experience, a suitable plan in the eastern counties of England, I have no means of knowing whether it would be profitable to lay down in the South of Scotland with this plant. At almost every point, then, connected with this subject the writer is sure to be confronted with difficulties arising from the want of that information which might, and should, be provided by local experimental farms. But though the means for writing positively for the various localities do not exist, it is clear that success may be attained in various ways, and it will be useful to enumerate them here in one group.

There are, to begin with, the methods of Arthur Young, who, as we have seen in the preceding chapter, approves of sowing the seeds alone in August as being the best method; secondly, of sowing them in July with buckwheat; thirdly, with rape in August, on soils not liable to bind with treading; fourthly, of sowing them with wheat early in September; and lastly, the worst method in his opinion, sowing them with spring corn. Of the agriculturists whose opinions are quoted by him one sowed with beans, which he found more successful than any plan he had tried; while another sowed his grass seeds amongst turnips in the spring as they were fed off by sheep, and found that the grass "flourished beyond any other." Then there is the system successfully practised by the late Mr. John Wilson in Berwickshire for many years, and of which he gave a full account in the *North British Agriculturist* of January 21st, 1885. His original practice

was, after turnips, to sow up with 2 bushels of Koenigsberg tares, 2 bushels of oats, half a bushel each of Italian and perennial ryegrass, 4 lbs. each of alsike, white clover, and trefoil, and 2 lbs. of cow clover. His later practice was to diminish the ryegrass, and substitute 4 or 5 lbs! of cocksfoot and timothy. He cut the crop before it reached the full blooming stage, and made it into hay. In the case of very rich land he omitted the tares, and sowed 3 bushels of oats, and cut the crop for hay whenever they were fully shot, and before the grain had formed. The late Mr. Faunce de Laune's experience was—and a very extensive experience he had—that grass may be grown equally well with or without a crop, and after any crop, excepting clover, for, sown after clover, he found that the grass most conspicuously failed. I now turn to a consideration of that most important of all points connected with laying down land to grass—the subsequent treatment of the pasture.

Some years ago, when discussing the whole question of grass with a farmer who is most skilful in laying down, and still more so in managing, his pastures, he said that the management of the pasture is even of more importance than the selection of the seed and the preparation of the land. This remark I am particularly anxious to impress upon all those who are inexperienced in laying down land to grass, because it is from the too common, careless treatment of young pastures that such a number of complete and partial failures occur. Farmers who have hitherto been in the habit of only laying down grass to lie for a year, or two years, and treating it in the way such grass is usually treated, are too apt to treat in a similar manner land laid down to permanent pasture, or that is to lie for five or more years before being again ploughed. And it is of the more importance to dwell on this point, because the mixtures which ought to be used for five or six years' lays, or for permanent pasture, are so much more

expensive than those usually sown in land to lie for a short time.

It is of great importance to leave a long stubble when cutting corn with which seeds have been sown in spring, to shield the young plants from frost and sun, and cold winds; also to prevent the topping of the clovers and grasses, which, of course, bleeds them, and should this topping be followed by frost—by no means an impossible thing in some seasons—serious injury would be caused. One of the worst errors usually committed by farmers who have sown out either with or without a crop is to turn lambs into the young pasture the moment there is a supply of grass for them. By doing so they acquire a slight gain, which is sure to be followed by a loss that far outweighs the trifling advantages obtained; for many of the young grass plants, having obtained but a slight hold of the ground, are pulled up by the roots (I have watched this cheering process), others have their roots ruptured, and so are easily thrown out by frost, while others —very small plants from seeds that have germinated late—are injured, and perhaps stamped out of existence if the weather is wet; others, again, are injured by the urine of the sheep, and by being lain upon; and, lastly, all the plants are injured by being cropped at that early period, as the root growth is checked, and they are therefore hindered from establishing themselves as deeply in the ground as they otherwise would. For all these reasons, then, it is obvious that, as a rule, stock should not be allowed to enter a young grass field during the year in which the seed is sown. If, however, from any cause, the barley should be short and scanty, while the growth of the grasses and clovers is luxuriant, and likely to be injured from the grass being laid; or, as in the case of the Bank field experiment (*vide* Appendix III.), where it was desired to restrain the growth of the chicory and the strong-growing grasses, then the field may be lightly grazed with

lambs and calves after harvest, without any bad effect. But it is important to remember that before any stock is admitted to the fields the land should be rolled, so as to prevent any injury to the grasses, many of which are sure to have but a slight hold on the ground. It is important to remember that rolling in warm weather makes the land warmer, and in cold weather, colder.

The next error, and one which is often committed, is that of failing carefully to roll the land in the beginning of winter and the spring following, for, in consequence of this neglect, the plants are liable to be thrown out by frost, and also to suffer from drought in the spring. And when I say carefully I mean that the land should be rolled with careful regard to the weather and the state of the land, which is very apt to be too damp or too dry, and I have had land of my own injured by being rolled when in too damp a state. Having the land well rolled enables a shower of rain to be much more effectual than it would otherwise be. When the soil is not rolled, and therefore loose, the water of a shower would quickly evaporate and be easily carried away by the wind, whereas the rolled soil would cause a shower to go much further in supplying the plants with moisture. Rolling would sometimes have the effect of keeping plants alive which would otherwise die. When my steward mentioned to a farmer visitor the importance of rolling, he said: "Oh, we have no time for rolling." But if the farmer seems often to have no time to spare for the valuable, and indeed most important work of rolling, he seems to have no difficulty in finding time for the harmful practice of raking the stubbles of his young grass fields. This is most objectionable, as the teeth of the rake sometimes pull up, and sometimes rupture, the roots of the tender grass plants, and the stamp of the horses must often destroy late spring seeds, which not infrequently germinate close to, or immediately after, the time of harvest.

A third, and very important error, is commonly committed by overstocking the land early in the spring following the year in which the grass seeds have been sown, for Sinclair "found, on repeated trials, that cropping seedling grasses before they had produced flowers had the effect of retarding and weakening the after-growth of the plant for that season very much." And on my referring the point to Mr. Carruthers—botanist of the Royal Agricultural Society of England—he replied as follows :—

"The after-growth of grasses depends on the strength of the plant, and especially on the hold it has on the ground. Up to flowering the plant is making itself above and below ground. Flowering and fruiting are exhaustive processes, and while this goes on the plant does not extend itself; but the after-growth of the plant will be improved by its growing as long as it can up to flowering."

And it is for these reasons that I prefer to take a crop of hay in the first year,* and this seems to be the usual practice, if I may judge by the opinions collected on the subject by the Royal Agricultural Society, and which appeared in the *Journal* of April, 1888. Of the agriculturists consulted (of whom I was one) sixteen mow the first year, three do not mow, one may mow

* Our subsequent experience shows that, though in the case of the grass seed mixtures formerly used it was considered advisable to take hay the first year, and not to graze the pasture in the spring of the first year, pastures sown with the Bankfield or other Clifton Park mixtures can either be grazed in the first year up to the 15th or 20th of May, and hayed afterwards in the same year, or grazed throughout the first year and hayed in the second year, or any subsequent year that may suit the plans of the farmer. The Bowmont-side field—17 acres—for instance, was sown in 1904, grazed throughout 1905, and hayed in 1906, when it gave certainly more than two tons an acre of hay, and the aftermath afforded fine grazing, and this year (1907) the grazing is most satisfactory. Farmers, then, who desire to keep the first year's grass entirely for grazing, instead of, as customary, haying the first year, can, if my mixtures are used, reserve all their first year's grass for their ewes and lambs.

first year, one mows sometimes, and one mows and grazes alternately.

But besides the obvious advantages of not cropping the seedling grasses either in the autumn or spring * following laying down, and, allowing the plants to begin to flower before cutting them for hay, there is another great advantage from adopting this course, as it gives a good opportunity for re-seeding vacant places; for, however carefully land may be laid down, it will be found that there are always many vacant spots, and though those may not seem, at first sight, to amount to a considerable area, let any one take a rake and some seed, and do the work himself (as I have), and he will soon find that they are far more than one would be inclined to suppose.† It is true that these gaps would eventually be covered over, but it is important to remember that our fields, like our minds, are liable to be filled with weeds if vacancies are left for their growth, and I consider it, therefore, of great importance to re-seed vacant places, though they be only a few inches wide. To do so, I have found, will cost about a shilling an acre for labour. Two women, or boys, should go together. One should have a rake and scratch the ground, and the other put down the seed, and these operations should be carefully superintended. When the Duke of Wellington was once asked by Lord Mahon (afterwards the Earl Stanhope)

* The subsequent adoption of the Bank field mixture (*vide* Appendix III.) calls for a modification of this remark in consequence of the use of such a large proportion of the strongest grasses, which would, if not kept back by grazing to a late period in the spring, give a coarse hay. For the benefit of the subsequent grazings, and the pasture generally, we have also found that a crop of hay, if more than two tons an acre, is a disadvantage. We have also found that by grazing in spring the chicory is so suppressed as to cease to be an objection in the hay crop.

† The steward at Clifton has sown several large fields without any vacancies, but these were fields of light soil where the seeds were less liable to fail.

what was the principal cause of the success of his campaigns, the Duke replied—"The real reason why I succeeded in my own campaigns is that I was always on the spot. I saw everything, and did everything for myself." Farmers should apply this anecdote to themselves, and the proprietor, too, if he wishes his fields to be so well filled with good grasses that there is no room for weeds and bad grasses; and do not let the latter rely on his farm manager or steward, or both. I have both, but, on looking into the work on one occasion, I found that, partly from carelessness and partly from the wind having sprung up, the seed was largely landing, not on the vacant spots for which it was intended, but on the adjacent grass.

I have remarked on the importance of filling up the ground with the view of keeping out weeds and bad grasses, but there is another enemy which must not be lost sight of—moss, which will speedily reappear in the vacant places, and spread from them. And as regards moss, it is the same in the case of earth in a pot should the plant which occupies it be in an unhealthy condition, and so not only decline above, but make little root growth below. The soil thus soon becomes solidified, or, in other words, loses its good physical condition, and then it begins to grow moss. And the springing up of moss in a field is really owing to the exposure of the land to the elements, and, besides, to its not being sufficiently kept open by the roots of plants. I was particularly struck with this fact in the case of a field in an alluvial flat which I had laid down to permanent pasture. On one side of the field there was a knoll of about six or seven acres, and, after sowing the whole field with the grass mixture suitable for such land, I added, to the land of the knoll, burnet, chicory, sheep's parsley, ribgrass, yellow suckling clover, and kidney vetch. These not only aerated the land, but filled it up closely with plants, and the result was that the poorer land of the knoll surpassed the land of the rest of the field,

and was quite free from moss, which soon began to appear on the land sown with the ordinary mixture suitable for the soil. This is a point to which I shall again allude when treating of the quantity of seed which it is desirable to sow, but I may add here that I was lately struck, in the case of a very mossy field, by the effect thistles have, evidently from their aerating the soil, in suppressing moss. On our hill pastures the barest places have always most moss, and such bareness is really owing to the almost exclusive close grazing of pastures with sheep. It seems to me quite clear that by increasing cattle and diminishing sheep you would certainly lessen moss, and much improve the pastures, as letting up the grass has a tendency to keep the ground more open, and the land therefore better aerated (*vide* Appendix III.)

We are often told that the requirements of the farmer impel him to manage his pastures badly, but, from my own experience in the case of an excellent tenant of my own, I can see that it is more often owing to a mixture of carelessness and want of skill that pastures are mismanaged, and the tenant in question, from his attention and judgment in judiciously shifting his stock, has at once more stock and more grass on his land than any farmer in this part of the country. I was particularly struck with this point in the case of one of my grass parks, which was let to him for two consecutive seasons. It consisted of grass in the third and fourth years—the proverbially trying fourth year—and yet he kept more stock on it than has been kept on my best old pastures, which were let to tenants, while all the time the field had an ample supply of grass.

I turn, lastly, to the consideration of the subject of the management of pastures, so as to obtain from them the greatest amount of winter and early spring food, so that we may be able to maintain our flocks in the most satisfactory manner, and with the smallest possible

assistance from root crops; for, as Sir John Lawes has pointed out, if we deduct the litter and food required for horses, grass land can produce more stock than arable, and it must always be remembered that the cheapest food we can grow for stock is grass. The last is a fact that seems to have been long ago perceived, and the bearing of it on our present agricultural conditions, and the deduction that should be drawn from it, are of the utmost importance.

I have said, in a previous chapter, that the rapid production of a good turf is the key to all our agricultural difficulties, so far as these can be solved by the wit of man; but it must be considered that this method of solution can only be fully successful if the cheapening of production, which we can alone attain through the agency of turf, is developed all along the line. I have shown how, by the agency of turf, in the case of lands to be kept in arable, good crops of roots and cereals may be produced at the lowest possible cost. It remains to show how grass lands should be managed so as to aid still further in lessening the cost of production by reducing the area of the root crop, and therefore the area under plough, to the lowest possible limits. This is a point our ancestors successfully grappled with, and we can only do so, as far as I can see, by following their example. Let us, then, revert to the methods they practised, and which have been alluded to in the last chapter, and one of which, as we shall see, is still practised in South Wales.

And first of all, let us consider the value of what, in Arthur Young's days, was termed rouen—a word which I have been unable exactly to trace; the nearest approach I can find to it is roughings or rowings (aftermath), a south-country word given in his "Provincial Glossary" by Francis Grose: London, 1811—which seems to have been particularly applied to aftermath preserved for spring use. As it is a short word, it may be as well to use it, and more especially

as it will probably be even more used in the future than it was in Arthur Young's days.

The practice of relying on rouen for spring use seems to have been a very ancient one, and I may remind the reader that Arthur Young speaks highly of it after an experience of twenty-five years of its value, and that he states that he "scarcely knew a person that tried it who ever gave it up." He complains of turnips as being expensive, and liable to be injured by frost, while after his experience of the winter of 1794-95, which he speaks of as the hardest ever known, he was able to declare that rouen was as safely to be relied on in severe winters as during the milder ones in which it was tried. The grass, it was pointed out by another agriculturist quoted by Young, is much more early and productive if, after mowing, no stock is turned in till spring, as the dry herbage shelters the young grass shoots, and thus promotes their growth.

But there is another ancient practice which Young, as we have seen, alludes to under the term fog, given, he states, in South Wales to the growth of the whole year kept till the ensuing winter and spring—a practice, he tells us, "commonly found nowhere else." Stock of all kinds, he says, were fed on it during these seasons, and the system was found to kill moss, and improve the grass by the quantity of seed produced; he further states that an acre of fog will support more cattle than one acre of hay. I have made special inquiries, and have obtained the following information from reliable sources :—

"The custom you refer to," writes my informant, "is still in existence in parts of Cardiganshire, Carmarthen, and Pembroke. It is generally termed 'fogging the land.' Owing to the proverbial wet weather prevailing in South Wales, many farmers, rather than run the risk of a poor hay crop, prefer leaving certain fields ungrazed from July till about February, when the milch cows are turned thereon, then some young cattle generally follow, and the horses get the last bite. Much of the grass

having withered, with some green intermixed, it is considered very beneficial as preparatory to the stock being turned into green pastures. The system has also its disadvantages, as by allowing the grass on the land, it tends to destroy the most tender and nourishing grasses, and ultimately the quality of the pasture becomes very much coarser.* The fogging of land certainly tends to destroy moss, and many of the fallen seeds will, of course, vegetate. Mr. Young is right with regard to one acre of fog being of more value than one acre of hay, provided it is a mild winter, with but little frost and snow, and in a sheltered locality."

I would here observe that the reader must not suppose that the disadvantages alluded to by my correspondent must occur always; on the contrary, they need never occur in the case of well laid down pastures, and I had an interesting proof of this when, on the 7th of June, 1884, I visited, in company with some landlords and tenant-farmers, Mr. Faunce de Laune's pastures at Sharsted Court. In one case my friend had allowed a pasture in its fifth year to grow up, intending to cut it for hay, but for some reason or another he changed his mind, and turned sheep into it, which were kept on the pasture in the autumn, winter, and spring following. The result extremely astonished one of the oldest, most experienced, and intelligent graziers present, who could not at all account for finding on the 7th of June such clean, level, close turf, with grasses as fine as those on a lawn, following on the letting up of the pasture the year before. But the explanation is simple. Ordinary pastures, if so treated, would certainly show deterioration, because they usually have a considerable proportion of weeds and inferior grasses—holcus especially. Were such pastures, then, allowed to flower, and then grazed with sheep, they would pick out the good kinds of

* This seems to show that the land should only be hained once, say, every four years, as an occasional haining could, I should say, do little harm to the smaller grasses.

grasses, and reject the bad grasses and weeds. Then the large grasses, being thinly distributed in the ground (as they commonly are in most old pastures), would assume a coarse and hassocky appearance, and the stems, in consequence of the large grasses being thinly distributed, being very strong, would not be closely eaten by sheep. But when (as in the case of Mr. de Laune's grass under consideration) the land is full of large grasses they keep each other in subjection, or, in other words, fine; and as there are no weeds nor bad or coarse grasses to be rejected by the stock, the whole pasture, or what may be called the standing crop of hay, is grazed evenly over during the course of autumn and winter; on the arrival of spring you have a clean field, and up at once starts a fine and even pasture. The Bank field experiment (*vide* Appendix III.) has shown conclusively that as fine a pasture as could be desired may be formed from the largest grasses. In this case 14 lbs. cocksfoot, 7 lbs. each of tall fescue and tall oatgrass were used, and only one small grass, *Poa trivialis*. When such a combination is used you have all the drought-resisting advantages of the large grasses, with the increased vegetable matter from their large roots when the pasture is ploughed up, and by grazing the pasture late in the spring—say, up to the 15th May—you can produce as fine hay as could be desired.

Another great advantage from letting a pasture up at intervals of several years is, as we have seen, that not only is it re-seeded, but the moss is destroyed, should there be any present. The latter is a point of great importance, and one which I have closely studied, and I am now satisfied that moss is usually caused by the consolidation of the surface soil, which commonly takes place where pastures are continuously and closely grazed, and not merely, as is commonly supposed, from chemical poverty. I was particularly struck with this in the case of a small enclosure I had made in a field

with the view of testing the proportions of plants in a young closely-grazed pasture in which moss had made its appearance, but when the grass was let up in the enclosed plot the moss soon disappeared, or nearly so, and a close observation showed that much of it had been dragged up by the rising grass; I could see it in some cases hanging to the seeding stems. The soil of the enclosed plot soon became comparatively soft, while that of the field was hard and, comparatively speaking, consolidated. I have also observed the same point in the case of pleasure grounds, part of which had been hayed for a great many years past, while part had been kept as lawn. The latter was full of moss, while the former had hardly any, and the surface of the lawn was hard, while that of the hayed land was soft and open. Whenever, then, moss appears in a pasture it would seem to be advisable to let the pasture up in the summer, on the Welsh fogging system, and put on stock either in November or in the early spring. Many of our hill pastures—in fact, most of them—are heavily afflicted with fog, and if, say, 50 or 100 acres were annually treated on this system, I think that the whole pasture could then be gradually improved, and that at no further expense than that of fencing off, with moveable fences, the pasture to be operated on.

It has been pointed out to me—and, indeed, it is sufficiently obvious—that in the case of pastures preserved for winter and spring use there would be a certain risk from snow, and, were the pasture composed of short grasses, this might be serious; but by using liberally the seed of the tall grasses this risk would be much reduced, and it is a risk that the farmer might easily provide against by keeping some hay in reserve for such a contingency. But in any case, it should be considered that the risk of relying on foggage for winter and spring use would certainly be less than relying on turnips, which are not only liable to turn out a poor crop, but to be much injured by frost, and

which, besides, are certainly not nearly so suitable a food for sheep as foggage.

In concluding this chapter, I may observe that I can see no better way of fighting our two great enemies, turnips and cereals, than by the adoption of a system of rouen and foggage, combined with a liberal use of oil-cake whenever the prices of it are as low as they are at present. And in abolishing cereals as far as possible, and only growing enough for consumption on the farm, it is cheering to think that we shall be carrying out the principles of political economy, and all those trading laws which are so constantly pressed on our attention. We shall produce, what we can produce most cheaply, grass, and the inhabitants of other climates—warmer ones with cheaper labour—will produce for us all the grain we require.

CHAPTER VI.

FORAGE PLANTS.

"NEVER revert to the past" seems rather a wholesome maxim. When I first heard it, many years ago, I thought it a very strange one, but I do not do so now, as a more extended experience has shown me that, by referring to the past, you are often liable to fall into a trap rather than into the hands of a trustworthy guide; for there are two great dangers in relying on the past action of our predecessors—the one, as I have previously pointed out, that it is difficult to find any set of present circumstances exactly on all fours with those of the past; the other, that what has been done in the past may have been done, not on sound principles as to what was best to be done, but for some other reason altogether, and that the action taken on that reason may be partially wrong. When, for instance, I began to turn my attention to farming here, I was struck with the fact that the farmers usually began their nineteen years' leases by a heavy application of lime, though this is easily washed out of the soil, and should be applied little and often, and I was told that small applications were of no use. But I found on inquiry that in Durham, where eight-year leases were usual, the farmers limed every eight years, while in Gloucestershire the custom was to lime in small quantities every four

years. But the explanation of the action of the Scotch farmers really was that, while they thought they were carrying out the results of a well-founded experience, they were simply blindly working by a custom which arose from the length of the leases, and the desire of the farmer to get the largest benefit from his expenditure. But his action, resulting from his imperfect reasoning, was wrong, for he would have obtained a greater benefit by applying his lime at two different periods of his lease. There, then, is an instance of the so-called practical experience of the past, which is too often a custom which has arisen from erroneous reasoning. And when we come to consider the apparently inexplicable circumstance that the farmers of this country should still prefer an inferior grass to a much better one—ryegrass to cocksfoot—for their temporary, and often for their permanent, pastures, we shall see still greater reason for subjecting the experience of the past to an extremely close scrutiny, for it either may or may not be a really well-founded experience. In the case of the preference for ryegrass shown by most farmers, the cause, as far as I can learn, seems to be mainly a purely accidental one, and the subject is of such interest and importance that it may be well to quote in full a note on the point, which has been sent to me by Mr. James Hunter, the well-known agricultural seedsman of Chester. It is particularly interesting, I think, from the concluding sentence, which tells us that had not Mr. Faunce de Laune gone back to Sinclair to find out the truth we should probably be pretty much where we were twenty years ago. Mr. Hunter's note is as follows:—

"The grass seed pamphlets of the leading seed merchants in England, up to 1882, may all be said to have derived their information from Lawson's 'Agrostographia;' and, as an excessive use of ryegrass was there recommended, the error extended to all the trade pamphlets. Lawson obtained his information from Sinclair, but Sinclair did not recommend the use of much ryegrass.

"In 1825, when Sinclair had finished his great experimental work for the Duke of Bedford, and had published the second edition of his book, he became a nurseryman at New Cross, near London. Shortly afterwards Mr. Charles Lawson, of Edinburgh (Lord Provost of Edinburgh in the early sixties), went to New Cross Nurseries, and no doubt studied the subject of the grasses there, under Mr. Sinclair. In 1833 Mr. Lawson, having returned to Edinburgh, and being engaged in the seed trade, wrote his paper on grasses, which appeared in the *Quarterly Journal of Agriculture*, Vol. IV., 1834 (see the volume I have sent you, page 714). As ryegrass was almost the only grass seed dealt in at that time, and other species were difficult to obtain, Mr. Lawson seems to have arranged the quantities in his tables to suit the circumstances, and so he recommended the use of no less than from 12 lbs. to 30 lbs. of perennial ryegrass per acre (with other seeds) for laying down land to permanent pasture. But that was not Sinclair's teaching. At page 243 of 'Hortus Gramineus Woburnensis,' 2nd edition, 1825, Sinclair gives his selection of seeds for permanent pasture, and although there is a certain vagueness, on account of the quantities being chiefly given in bushels, yet it is fair to assume that in Sinclair's opinion the proportion of ryegrass to the other species in a pasture should be about *one in twenty*. Lawson, however, recommended that ryegrass should compose from one quarter to one half of the whole seeding. The 'Agrostographia,' published by Lawson, continued to recommend the excessive use of ryegrass, and the teaching of this work was adopted by the seedsmen of Great Britain without question. At that time the Lawsons' supplied the English seedsmen with their grass seeds, and, in fact, controlled the trade in natural grasses. Indeed, it may be said that they not only supplied the other seedsmen with the seeds, but also with the ideas and information in reference to the subject. Thirty years ago the writer was for three years warehouse manager in the grass seed department of Lawsons', and is consequently acquainted with the facts.

"To Mr. Lawson is due the credit of creating sources of supply for the various grass seeds, but it is a pity he did not revert to Sinclair's teaching as to the limited use of ryegrass as soon as the other grasses could be freely obtained. If Mr. de

Laune had not gone back to Sinclair to find out the truth, I fear we should still have been pretty much where we were twenty years ago." "J. H."

"July 27th, 1896."

Taking into consideration the controversy about ryegrass that has raged in recent years, Arthur Young's remarks on this grass and cocksfoot are very interesting. Sir Mordaunt Martin, he tells us, found cocksfoot much more profitable than ryegrass. It grew in midsummer when everything else was burnt up. It was cultivated in Norfolk and Suffolk with great success instead of ryegrass. Young recommended it widely in consequence of its earliness, largeness of produce, and yielding an ample rouen (aftermath). He quotes a Hampshire farmer who, in 1812, asserted that since cocksfoot had been substituted for ryegrass 100 additional sheep had been kept on his farm of 240 acres. When recommending cocksfoot, Young says "that the exclusive attention that has been given to ryegrass has proved in a thousand instances most prejudicial."

Curtis, in his "Practical Observations on the British Grasses," 4th Edition, London, 1805, says :—

"Ray-Grass (or ryegrass) still continues to be the only grass whose seeds can be purchased for the purpose of laying down meadow and pasture land; and how inadequate that grass is, for such a purpose, is known to every intelligent farmer. Why, indeed, the *Lolium perenne* should originally have been made use of, in preference to all the other grasses, cannot, perhaps, be satisfactorily accounted for; most probably it owes its introduction to accident, or to its being a common grass whose seeds were easily collected, rather than to its being preferred from any investigation of its merits compared with the others. However this may be, there appears to be no reason for excluding the others—for it would appear exceedingly improbable, that, of upwards of a hundred grasses growing wild in this country, the Author of Nature should have created one only as suitable to be cultivated for pasturage or fodder."

"Taking it for granted, then, that there are other grasses, superior in many respects to the Ray-Grass, this question naturally arises—How comes it that they have not found their way into general use? To this it may be answered, improvements in any science, but more especially in Agriculture, are slow in their advances; and, perhaps, no class of men adheres more pertinaciously to old prejudices than the farmer."

It is important to observe that Sinclair not only restricts the use of ryegrass to about one-twentieth of the mixture he thinks advisable for permanent pasture, but recommends its use, though in small proportion, for alternate husbandry. For the latter he advises a mixture containing no less than three-fourths of cocksfoot, while hard fescue, meadow fescue, rough-stalked meadow grass, tall oat-like grass, timothy, ryegrass, and clover should make up the remainder of the mixture, or, to use his exact words, "should be used in smaller proportion." But neither Sinclair (though he alludes to the superiority of cocksfoot to ryegrass as being less impoverishing to the soil, and affording a greater quantity of vegetable matter when ploughing up) nor my late friend, Mr. Faunce de Laune (though the latter did allude to the question of the disintegration of the soil as a subject which had not been sufficiently studied) have at all attempted to regulate the mixture they propose with reference to the effect of the roots of plants in keeping open and deeply aerating the soil. And, as we have seen, to find any account of such a mixture having been advised in the past we have to go back more than a century—to Arthur Young, who had recommended the use of plants that would have this very important effect on the soil, though I may observe he did not allude to this, either because he thought it too obvious to be worth mentioning, or because he had not taken the point into consideration.

I have now to observe that if the conclusions I have arrived at are correct—*i.e.*, that a grass mixture should consist of the seeds of plants, some of which are of

deep-rooting and drought-resisting character, so as at once to draw support from the lower strata of the soil, supply food when other plants dry up in a drought, and deeply disintegrate the soil, and permeate it with vegetable matter; if some of the plants should, besides, be of a kind especially calculated to promote the health of the stock, and also act as a preventive against disease; and if the greater part of the mixture should consist of grasses calculated to give the largest possible amount of produce, it is evident that all the existing mixtures for permanent pastures must be largely reconstructed, so as to meet, as far as possible, the above-mentioned requirements. And seeing that, from the existing agricultural conditions, temporary pastures will in future be allowed to lie from four to six years, it is equally evident that alternate husbandry mixtures should be composed with the same ends in view, and so should pretty closely resemble those used for permanent pasture. For laying down, then, to permanent pasture, and in the case of land to lie from four to six years, I now use much the same mixture, with this difference, that in the case of the latter I omit meadow foxtail, and, in the case of light lands, timothy too, as it is considered unsuitable for dry lands. As to the proportion of grasses, plants, and clovers that should be used, I am far from saying that the proportions I have used are the best. On the contrary, much more experience will be required to show the proportions that should be used for our varying soils and climates, but I feel sure that the principles on which my mixtures are founded are sound, and that the results from them on this property have been most satisfactory, and, indeed, in the case of the poor lands, the results have surprised me, and also farmers of great experience. I may here mention that during my long experience I have used a great variety of mixtures, and with varying degrees of results, but I do not quote any of them, because I do not consider that they were

founded on those principles which I now see should be adhered to when laying down land to grass. Two of the mixtures I have sown in 1895 were used for the two poor land fields to which I alluded in a previous chapter, and I also give the following, which was used for a field of very different character, on the low-lying land on the Clifton Park portion of the estate, some five miles distant from Clifton-on-Bowmont. In the case of the last, then —the Longshot field, a deep, strong soil on a low-lying alluvial flat—the following mixture, on the 25th of April, 1895, was sown with a thin seeding of oats:— 5 lbs. each of cocksfoot, meadow foxtail, and tall fescue; 7 lbs. of meadow fescue, 4 lbs. of timothy, and 1 lb. each of wood meadow grass and rough-stalked meadow grass; 2 lbs. each of white clover, alsike, and perennial red clover, kidney vetch, and lucerne; 3 lbs. of chicory, 8 lbs. of burnet, 1 lb. of sheep's parsley, and ½ lb. of yarrow. The field—one of 15 acres—was, in 1896, cut for hay, which amounted to 36 tons, 14 cwts., or nearly 2½ tons per acre; and the aftermath, grazed with lambs, was an excellent crop. Two trenches were cut in the field to a depth of about 3 feet, and on September 11th, 1896, in company with my friend, Dr. Voelcker, I carefully inspected the land in order to estimate the depth to which some of the plants had penetrated. The results were particularly interesting as regards chicory, which seemed to have a profound contempt for the very hard pan, which we found at about 14 inches below the surface, and which was about 10 inches to a foot in thickness, and was so hard that a powerful man with a sharp spade had to use great force to break it open when we were tracing the descent of the chicory roots, which had passed straight downwards without any deflections. As the seed was only sown in April, 1895, it is interesting to find that the roots can go through this hard pan into the soft subsoil, which was a sandy clay, in such a comparatively short time; and we noticed that, in passing through the pan, the strong roots

of these plants, notably the chicory, had succeeded in disintegrating the apparently impenetrable pan.* Altogether, we estimated that the roots had gone down about 30 inches. The burnet and kidney vetch roots had gone down about 20 inches, and the lucerne from 8 to 10 inches. It was interesting to observe how the clover plants had turned into plants more or less robust and large, in accordance as their roots were supplied with a larger or smaller quantity of those nodules which, in the opinions of the best authorities, have been now proved to supply the plants with nitrogen derived from atmospheric sources. Altogether, we came to the conclusion that the roots of these plants are capable of doing all the work of a subsoiler in breaking up the pan, which is often the most formidable obstacle to be contended with in the cultivation of all our old arable soils. I increased the chicory in the case of this field by one-third, as I wished deeply to pipe, and so aerate the soil, and bring up the manurial matters which must have filtered downwards in past years. Arthur Young, I may observe, objects to chicory for hay on the ground that it is difficult to dry, and no doubt there is something in this objection; but I have found two advantages from its use—one is that, as a certain proportion of it always throws up long strong stems pretty early, these support the whole crop, and so greatly increase it, and favour the grasses generally; the other is, that the stems of the chicory aerate the cocks of hay, and cause it to dry much more quickly. Hay with chicory in it should be used within a year, as, if kept longer, it creates much dust in the hay.† I usually sow 2 lbs. of

* This pan was composed of very small particles of soil washed down from the soil above. This pan evidently was not formed solely from ploughs and horses, but owed much of its hardness and compactness to the smallness of the washed down particles, which may be so small as to arrest capillary attraction.

† I have since overcome the objections to chicory as regards the hay crop by grazing the land late in the spring before shutting up for hay. (*Vide* Bank field experiment, Appendix III.)

chicory, and think this is, as a rule, a sufficient quantity, but that in dry lands 3 lbs., and perhaps even 4 lbs., may be used with advantage.*

Since writing the preceding remarks I have had another visit from my friend, Dr. Voelcker, who inspected (September, 1897) the field, and at the close of the most prolonged drought we have ever had. Part of the field consists of strong clay, and my friend cut out of this, with his pocket knife, several sections of soil, in each of which was a chicory plant, and called my attention to the fact that the soil was soft and friable, having been kept in that condition by the powerful roots of the plant, and also, no doubt, by the moisture it had brought up from a depth in the land out of reach of the effects of the drought. I am now so satisfied with the results from deep-rooting plants that I am, as an experiment, going to add a pound of parsnip seed per acre to one of my next season's mixtures, in order to deeply penetrate the soil, and increase in it the amount of vegetable matter.† It should be considered, further, in this connection that, by virtue of the acids in their roots, plants have the power of making use of the manurial matter contained in stones and gravel in the land, and it has been found that if you bury in the soil a block of polished marble, the roots of plants will literally engrave the surface of the marble. One of my numerous correspondents, who had read a letter of mine in the *Scotsman*, wrote to me on the subject, and headed his letter, "Out of these Stones Bread," and it is literally true that plants can, in great measure, by virtue of the acids in their roots, supply themselves with

* From my experience this year (1907) I think that as much as 5 lbs. of chicory may be used with advantage, as this quantity (which was sown in the Front Field in 1906) does not interfere with other grasses either above or below ground.

† Parsnip seed was sown in the Outer Kaimrig field in 1899, but from that experiment I have formed the opinion that chicory is superior to parsnip, as a deep-rooter.

some of the materials for the manufacture of bread. Notwithstanding this unusually dry season, I have found that the roots of chicory plants only about five months old have gone down about 18 inches.

I now turn to the two poor land fields, one of which, as I have shown (*vide* page 29), was of the poorest and most exhausted soil imaginable. The kinds and quantities of seeds used in the mixtures are given on pages 30 and 31. The poorer field, the Inner Kaimrig, gave a crop, as we have seen in a previous chapter (*vide* page 32), of not less than 2 tons an acre, and the aftermath kept $5\frac{3}{4}$ lambs per acre for eight weeks, and afterwards 2 ewes per acre for fourteen days. The better field of the two, the Outer Kaimrig, was grazed with sheep and lambs as follows:—Three ewes and their twin lambs per acre from April 25th to July 10th, and afterwards about 2 ewes per acre up to October 1st.

In the opinion of my head shepherd the grazed field has given most satisfactory results as regards the amount of stock kept, and the effects produced on the stock were excellent, both as to their health and the progress made by the lambs. My factor (a practical farmer), who manages the farm, is of opinion that the results obtained could not be surpassed, and advises me to stick to the same mixture for the future. The fields, during my absence from home, were visited by one of the most advanced tenant-farmers in the South of Scotland, and as he has had great experience in laying down land to grass (having laid down to permanent pasture about 400 acres), I think it well to quote part of the letter he afterwards wrote to me:—

"I was very fortunate in going at the right time, as your hay-cutting was in progress, and so I had an excellent opportunity, both of seeing the grasses growing and amongst the hay on the high field at Clifton. The crop I thought a remarkably fine one for a field of light hill land. The first thing that struck me was the extraordinary take of red and alsike clover, compared to the small quantity sown per acre, which leads me to doubt the system pursued generally of sowing 12 or 14 lbs.

"The kidney vetch seems to be a remarkable forage plant to grow on light gravelly soil, and for such I think it very valuable. The burnet and chicory also seemed deep-rooting, fine plants for standing drought, and, from the state of the pasture, much appreciated by sheep, as they were so closely eaten down. For your fine crop of hay, however, I noticed you were in the largest measure indebted to the red and alsike clover. The grasses will, I have no doubt, show more later.

"The pasture field adjoining of young grass [the grazed field alluded to] astonished and pleased me even more than the hay. The amount of stock on it and the quantity of grass is wonderful, and your manager told me it was stocked in April. I remarked how closely the sheep had eaten the burnet and chicory, and here, again, how the kidney vetch showed on the gravelly soil."

As I had asked my correspondent to be kind enough to give me any hints or suggestions as to my procedure of laying down, he further remarked, in the letter quoted from, as follows :—

"I have a very strong opinion, and that founded on experience, that your system, followed by a liberal use of cake on the pasture, would show results even more surprising than those attained. This I mentioned to your manager, who said it was thought an objection to the sale of the lambs their having been fed on cake. Those who use cake for their lambs, from this time of year, prefer those who have learned to eat it. If I farmed Clifton I would spend £500 per annum on cake, and I feel *certain* it would pay. I spent £1,700 on it last year, and so I know something of the results, and I intend, so long as it is as cheap as it is now, to use more than ever. It is the only way land can be kept in condition and rents paid."

In the opinion, then, of the eminent agriculturist I have just quoted the farming of the future resolves itself into plenty of stock and abundance of grass and oilcake to feed it, and with his view I need hardly say that I entirely concur.

And here I must note one point of importance as regards the two poor fields to which his letter refers; that is, that neither were re-seeded in the spring,

and yet they were so completely filled with plants that I was under the impression that this operation, the necessity for which I have fully pointed out in a previous chapter, had been carried out. I regard this result as of great importance, for it proves conclusively that, when the conditions are as perfect as they ought to be, the quantity of seed used in the case of these fields is quite sufficient; and further, what I had hitherto thought to be impossible, that land can be so perfectly laid down that no blanks may occur. Careful tillage, then, and the careful seeding of the land, would often save the re-seeding of the land, which, as I have shown, will usually cost about one shilling an acre for labour, besides the value of the seed. I may add here that a very trifling, or rather apparently trifling, defect in the state of the land will often make a large difference in the results obtained, and of this I had an instance this year in the case of a field about two-thirds of which was laid down with oats, and the remainder with barley. The latter showed so poorly as compared with the former that one would have supposed that either the seed had been bad or that the crop had affected the result; but I found, on going into the matter, that the oat-sown portion of the field had been ploughed much earlier in the season, and that the soil had therefore had time to solidify, while the soil in the barley portion had been much more recently ploughed; though the whole field was smooth above, the soil in the barley portion was too open below, and as there was a drought many of the seeds had not sprung, or, having sprung, must have perished from want of moisture. I now propose to offer some remarks on the quantity of seed which should be used, a subject as to which there is a considerable difference of opinion.

And here the reader will remember that Arthur Young said, as I have pointed out in the chapter devoted to him and his opinions, that whatever system of laying down land to grass is pursued a liberal

amount of seed is essential to success. Mr. James Hunter, the well-known agricultural seedsman of Chester, tells me that of all his customers I am the most liberal seeder, and he has more than once even remonstrated with me as regards the quantity of seed I put down. This I was induced to do, partly from my own observation, and partly from the remarks of the late Mr. Brotherston—an excellent botanist, who had paid much attention to the whole subject of grasses and their cultivation—who was much in favour of liberal seeding, and the more I have considered the subject the more certain do I feel that Arthur Young is right as regards the opinion he held as to liberal seeding being essential to success. For what are the main points to be kept in view? Are they not to cover the ground as quickly as possible with as much grass as it will hold;* and an equally important, or even more important, point, to fill the land as soon as possible with a large quantity of roots, to the end that its physical condition may not only be maintained, but improved? And when we come to consider the numerous causes of loss that are liable to occur from defective seasons, the ravages of birds and field mice and insects,

* A pasture not fully occupied with plants renders the whole land more liable to suffer from drought, and this is, of course, more especially the case when drying winds sweep over it. In the case of a young pasture the conserving of moisture is obviously a point of the first importance, as plants more often suffer from lack of moisture at a critical period of their growth than from any other cause. The land may be ever so rich, but without a good supply of moisture the pasture cannot take advantage of the plant food present. Every bare spot in a pasture, then, though only an inch in width, has a tendency to starve the plants in its immediate neighbourhood in the event of the season being a dry one. The wind and sun of course dry up the bare patches. These patches draw into them, by lateral attraction, from the adjacent soil moisture which is speedily evaporated and carried away. Every bare patch, therefore, acts as a pump to draw moisture out of the land. Multiply these little pumps all over a field, and though each pump may be no larger than half a crown, it is clear that their total dessicating effect must be very considerable when drought reigns in the land.

and defective conditions of soil, is it not evident that if we wish to have a full take of grass we must put down plenty of seed? It is true that by liberal feeding with cake on the land, or by manuring in some other way, a thin supply of plants on the land will gradually tiller out and cover the ground; but while this process is going on what evils and losses are occurring! The numerous parts of the soil which are unfilled with roots run together, or solidify gradually from the action of the elements and the tread of the stock, weeds and bad grasses find ample spaces in which to establish themselves, and the production of the field is, of course, far below what it would have been had it been at once filled with grass plants; and the intrusion of moss is sure to take place in a greater or less degree, in accordance with the nature of the soil and climate. It should be considered, too, that if the plans of the farmer make it advisable that he should feed stock with cake on a fully-planted young pasture, he will obtain additional advantages from the land being well filled with plants. It is evidently better, then, from many points of view, to at once fill the ground with the plants you wish to remain in permanent possession, and that it pays better to spend a little more on seed than to make up, or partially make up, for the deficiencies of thin seeding by subsequent manuring, there can be no doubt. But what is a full seeding? or a seeding sufficient to insure the land being well filled with plants? If the selection used should be of the same kinds as those recommended by me, then it is plain that, from the results obtained, 20,000,000 of germinating seeds would be an ample supply, as the mixture I have used contains 19,931,145 in the case of the field cut for hay, and in which Italian ryegrass was put down to increase the hay crop; and in the case of the other field alluded to, and which was grazed, and the results from which could not be surpassed, 18,872,745 germinating seeds were put down. But seeing that, from the total absence of blanks in the

fields (a point to which I have previously alluded), all the conditions must have been extremely favourable, it is probable that it would be safer to assume that 20,000,000 of germinating seeds per acre should generally be used, though in the case of land in very fine tilth the quantity used by me, or, say, about 19,000,000 of germinating seeds, would be sufficient. In 1903 the Inner Kaimrig and Harewells fields, then being in fine tilth, in consequence of the vegetable matter grown on the land, were sown down with a reduced seeding (*vide* Appendix III.) In the case of the first field the take of grass shows that we have lost nothing by reducing the amount of seed. In the case of the second * it is rather early to form a decision, but, as far as we can see at present, no loss will occur from reducing the amount of seed, and certainly none has as yet occurred in the case of the hay crop and foggage obtained from the field this year. Let us now turn to a point of great importance, viz., the quality of the seed to be sown.

To an unskilled agriculturist a grass plant is a grass plant, and there is nothing more to be said about it as long as it comes up and flourishes. But there is, of course, as much, or perhaps even more, difference between grasses grown from different qualities of seed as there is between sheep or cattle of the same breed, and the quantity and quality of the herbage to be produced differ largely in accordance with the goodness or inferiority of the grasses from which the seeds put down have been gathered; and the evils arising from seed, which, though genuine, may be of inferior quality, cannot, as far as my experience goes, be remedied for a great many years—if, indeed, ever. As to these points, we have had ample experience on this property by giving parts of fields to rival seedsmen, and in one instance a whole field to one and a whole to another;

* Subsequent experience shows that in the case of the Harewells field the reduced seeding used has been adequate.

and the tenant, to whom I have previously alluded, has confirmed my experience, and one day said to me that if he hained, or turned the stock out of, a field sown with the seed of a certain seedsman the grass recovered far more quickly than it did in the case of another field sown with seeds supplied by another seedsman. And this supremacy of one plant over another of the same species is by no means so evanescent as one would be inclined to suppose, though eventually, from climatic causes and the conditions of soil, there would be a tendency for the inferior and superior plants to eventually arrive at similar powers of production, though this is a point which requires further investigation; and I am not aware of any experiment having been made with the view of determining how long it would take, say, for cocksfoot plants, grown from the finest New Zealand seed, to approximate to plants grown from the, comparatively speaking, dwarf plants which are natives of our country, or from the seeds of any other inferior cocksfoot plants. On one occasion, in 1884, I gathered cocksfoot seed from plants in this park, and Mr. James Hunter, of Chester, on June 26th, 1885, sowed it in line with New Zealand cocksfoot, American, and seed of German growth. He reported that the last three germinated on July 4th, and the former on July 13th. The Clifton Park cocksfoot plants were very dwarf, and quite different in habit of growth from the other cocksfoot, and gave a much smaller amount of grass, and yet it is almost certain that the fine New Zealand cocksfoot was the produce of plants very similar to those growing wild in this park. But though plants will, of course, in time improve or decline to the climate and soil they live in, it is probable that many years would elapse before a decided change would occur one way or another. The only means I have of forming an opinion here is in the case of a field, the Lake field, 20 acres—low-lying flat alluvial land—which was partly sown with seed supplied by a local seedsman, and partly supplied by one of the most

eminent seedsmen in England. The local seedsman knew that the comparison was to be made, and, no doubt, did his best, and there was no reason to complain of the germination or trueness of his seed, but the difference in the result was most marked, and the cattle declined to eat his plants so decidedly that one would imagine they had been fenced off the field. It was interesting to observe how exactly the cattle had stopped grazing at the exact spot where the rival seedsmen met, and eventually I had to send a boy to herd the cattle on to the acres which had been allotted to the local seedsman, and though the field (it was sown in 1884) is now (1898) grazed evenly over without compulsion there is still a superiority apparent in favour of the superior seed. In 1903 I enclosed two plots of 18 feet square in each seedsman's portion of the field, and, after letting the grass grow as if for a hay crop, had it cut and taken direct to the weighing machine. The result showed a difference of 17 per cent. in favour of Mr. Hunter's portion. The trial was repeated in 1904, when it was found that there was a difference of 13 per cent. only in favour of Mr. Hunter's portion. The aftermath of Mr. Hunter's plot showed in 1904 a marked superiority to that of his rival, and in 1905 the superiority of Mr. Hunter's plot was still more marked. From these facts it seems obvious that, in the case of laying down land to permanent pasture, great care should be taken to provide the very finest seeds.

Another difference also attracted my attention as regards crested dogstail. It is well known that stock reject the wiry flowering stems of this grass, but I was struck with the fact that the stems of seed supplied to me by Mr. James Hunter of Chester had a much softer and more succulent appearance, and on enquiry was told by my shepherd that these were eaten by sheep, though the stems of the wild dogstail plant are rejected. On referring this point to Mr. Hunter, he informs me that the seed which he sells of this plant is

collected from meadows on the Rhine in Holland, and adds that it is possible that, from the damp nature of the climate where it is collected, it may be more succulent than the wild native plant.

From the facts previously given, it seems evident that the whole subject of the difference of production in grasses of the same kind, but grown under different conditions of soil and climate, deserves close investigation, as, even from my individual experience, it seems evident that there are far greater differences in the result than might be supposed from sowing seeds of the most superior kinds, and that these results probably are carried on over a much greater length of time than one would be inclined, at first sight, to suppose. I now propose to take each forage plant separately, and offer some remarks as to its quality and general merits.

Cocksfoot grass *(Dactylis glomerata)* calls for little remark, as, to use the words of Mr. Faunce de Laune, "it is by far the most valuable of all grasses, because it grows on all soils, it produces the greatest amount of keep, it is the most nutritious grass; it also seems to grow faster and stronger in extremes of weather, either wet or dry, than any other grass." Taking into consideration its productiveness, it is the cheapest grass that can be grown for land that is to lie in grass for four or more years, for though timothy seed to start with is cheaper than cocksfoot the productiveness of the latter grass in the course of about three years pays for the extra cost of its seed. It is certainly the most valuable for temporary pasture, and Sinclair says that, "for alternate husbandry, it appears to have a greater variety of merits for this purpose than almost any other grass. It soon arrives at maturity, it bears cropping well, is very productive, and its nutritive powers are considerable. It is much less impoverishing to the soil than ryegrass, and when ploughed it affords a greater quantity of vegetable matter to the soil. It has been objected to cocksfoot

that it rises in tufts, and is apt to become coarse. But this objection will apply to every grass that is not sown sufficiently thick to occupy with plants every spot of ground, and that is not sufficiently stocked to keep the surface in a succession of young leaves. It is the practice of thin sowing, and the strong appearance of the plant, that occasion it to appear a hassocky grass." And he subsequently expresses the opinion that *Dactylis glomerata*, from its more numerous merits as compared with other grasses, should constitute three parts of a mixture of grasses adapted for the purpose of alternate husbandry. I have now a ten-year-old permanent pasture as fine as a lawn, and a mass of cocksfoot grass, but then I used 16 lbs. an acre of the finest seed. I have been particularly struck with the value of this grass in alternate husbandry in the case of the hay crop, and have found that it is a far safer grass to grow than any other, from its withstanding drought, and have found that I have had a most luxuriant crop of hay in a dry season, when my neighbours, who relied mainly on ryegrass and clovers, had very poor crops. But notwithstanding all that has been written in favour of cocksfoot for such a number of years past, I have often heard it objected to by farmers as a coarse grass. It is quite true that it may become so if thinly planted and badly managed; but just as from the human animal you may produce the finest kind of English gentleman or the bloodthirsty cannibal, who only differs from the brutes by being worse than them, so there may be produced from cocksfoot a beautifully-fine grass or a grass of the coarsest and most objectionable quality. In connection with cocksfoot it may be well to remind the reader that I have previously pointed out that, in making a pasture, regard must be had in particular to the quantity of the produce of a grass, and also to the safety of production from it in dry seasons. The nutritive value

of cocksfoot, it should be observed, is, according to Sinclair's analysis, 10 per cent. higher than perennial ryegrass. Sinclair remarks that the ryegrass ranks with those grasses which contain the least nutriment. It is seldom that, as in the case of cocksfoot, we can combine both qualities, but we must endeavour to do so as closely as possible, and that is why I rank tall fescue as second in merit in the list of large grasses.

Tall Fescue grass (*Festuca elatior*) is, we are told by Sinclair, nutritive and very productive, and one of the earliest grasses with regard to production of foliage early in the spring. It has also great powers of resisting drought, which, I need hardly say, is a quality of great importance, and more especially, of course, with reference to light soils in the, comparatively speaking, dry climates of the eastern sides of these islands. Writing on agriculture in 1888, in Morton's *New Farmers' Almanac*, Mr. Faunce de Laune says, with reference to this grass, "I imagined in 1884 that I was the first person who had noticed its wonderful quality of withstanding drought. But the same quality was also observed the same year in America, and it was only in October, 1887, that I found, in a book written by the late curator of Glasnevin Botanical Gardens, the same grass mentioned as growing luxuriantly on a dry calcareous soil."

I am informed by Mr. James Hunter, of Chester, the well-known seedsman, that :—

"Great care requires to be exercised in purchasing this grass, as there are two kinds supplied to farmers under the name of tall fescue—the first valuable, and the second worthless—and that is evidently why there is a difference of opinion as regards this grass. The former—*i.e.*, the valuable kind—is grown for its seeds in the Rhenish provinces in a limited district, and is supplied to seedsmen who will pay the price for it; and this price, the moment any increase of competition occurs, naturally runs up to a high level, and the difficulty of obtaining a regular and considerable supply of the seed at a reasonable price leads to

the importation of the tall reed fescue of New Zealand, which is an extremely coarse and harsh grass, and quite unsuitable as a pasture grass. Any one seeing it in a pasture would be sure to condemn it, and hence the bad reputation into which tall fescue has fallen. As the Rhenish seed costs about twice as much as that of the reed fescue from New Zealand, there is therefore a strong temptation to supply the latter instead of the former, and it is thus of obvious importance to obtain a guarantee as to the kind supplied, and also to send it to the botanist for examination. It may be well to mention that samples of the New Zealand species usually contain ergot."

Tall Oat-like grass (*Avena elatior*).—This is a very hardy, drought-resisting and productive grass (for which qualities it is much valued on the Continent), and, the reader may remember, was much esteemed and largely sown by the great Arthur Young, who, however, ultimately gave it up in favour of cocksfoot, which, in his opinion, much excels it. At one time the late Mr. Faunce de Laune considered *Avena elatior* to be a grass of medium quality, but subsequently saw reason to place a much higher value upon it, and states that in this view he was supported by Mr. Moore, the late curator of Glasnevin. Sinclair says that it "attains to maturity from seed in a very short space of time, and that it is very early and productive in the spring, and during the whole season grows rapidly after cropping, and the culms are succulent." But the produce, he tells us, "is very deficient of nutritive matter, which contains an excess of the bitter extractive and saline principles." There can be no doubt of its value for permanent pasture, but it is, in error, objected to by some for land that is ever to be lifted again, because of the supposed difficulty of eradicating it; but Sinclair recommends it for alternate husbandry, though in small proportion—the mixture he advises being 75 per cent. of cocksfoot, while the remaining 25 per cent. is to consist of hard fescue, meadow fescue, rough-stalked meadow grass, tall oat grass, timothy, ryegrass,

and white clover. Sinclair says nothing of the difficulty of eradicating this grass when ploughing up, and I cannot help thinking that the variety of tall oat grass which has bulbous underground roots is the kind to which objections have been raised on account of the difficulty of eradicating it. I have grown the tall oat grass extensively for the last twenty years, and have never experienced any difficulty with it when ploughing up. I may also remark that Arthur Young, who, as I have pointed out, at one time sowed it largely, says nothing about the difficulty of destroying the roots on again ploughing up the land.

I have now considered three grasses of great importance—cocksfoot, tall fescue, and tall oat grass—and they all three possess most desirable qualities, being early, drought-resisting, hardy, and productive. On reference to the table of relative productiveness (*vide* Appendix I.), the reader will see that they stand at 100, while two of the other tall grasses—timothy and Italian ryegrass—stand at 75, while meadow fescue and meadow foxtail—the two remaining tall grasses—only attain a proportion of 70. The first three grasses are thus 25 per cent. more productive than the secondly mentioned grasses, and 30 per cent. more than the last two alluded to. This question, then, naturally arises—Why should we not use the first three grasses exclusively for the large grasses of the pasture? Add to them rough-stalked meadow grass, and golden oat grass to fill up the bottom of the pasture, and also chicory, burnet, yarrow, and kidney vetch, sheep's parsley, and some lucerne—when the soil and climate are favourable to the last—alsike, late flowering red clover, and white clover. The mixture would then consist of thirteen or fourteen different kinds of plants, and supply that variety of food which is always so welcome to stock, and indeed to all graminivorous animals from elephants to mice. In these days, when farming profits are small at the best, and it is always a matter of doubt

as to whether there may be any profits worthy of the name, it is obviously of the greatest importance to put down a seed mixture which will at once give the greatest amount of production, and from the hardy and drought-resisting character of the plants, the greatest safety of production when seasons are dry or unfavourable. The season of 1896 was particularly dry, but, in spite of the great drought, a mixture closely approximating to that suggested above gave wonderful results, and the pasture remained of a beautiful green colour. I may add that even in the moister climates of Great Britain a preference should certainly be given to drought-resisting plants when laying down to either temporary or permanent pasture. It is true that in the moistest climates a dry season may not wither up plants which are not remarkable for drought-resisting powers, but seeing that very dry seasons would certainly diminish the production from grasses of inferior drought-resisting power, while such seasons would affect but little grasses and plants best able to resist drought, it seems evident that a most decided preference should be given to drought-resisting plants, whether the climate is a dry or a moist one. There is, however, an exception to be made in the case of rough-stalked meadow grass, because, though it does suffer from drought, it recovers rapidly after rain, and also spreads so quickly that it is valuable for filling up the bottom of a pasture, as I have elsewhere shown, even in dry and exposed situations.

I now proceed to make some remarks on the other grasses commonly used for permanent and temporary pastures, and also on the other plants usually associated with them.

Timothy grass (*Phleum pratense*), as the reader will remember, is, by the table I have supplied, 25 per cent. less productive than the first three grasses I have treated of—cocksfoot, tall fescue, and tall oat grass—which may readily be understood when we read in Sinclair that "this grass is very deficient in the produce

of aftermath, and is slow in growth after being cropped," two very serious defects, which certainly do not seem to be compensated for by the fact that its early spring produce is said by Sinclair to be more nutritive than cocksfoot in the proportion of 9 to 8, though the quantity of spring produce was the same in the case of both plants. Timothy is unsuited for dry soils, and does not appear to have the merit of being a drought-resisting plant. It is recommended by Sinclair partly because, as it does not put out its flowering stems till June, it can be fed to a late period of the year without injury to the hay crop. But in this respect it is equalled by cocksfoot, and as that grass is distinctly more productive, and certainly suitable to nearly all soils and situations, and also more drought-resisting, I confess I am unable to see why it should occupy space which might better be filled with cocksfoot or tall fescue. Owing to its unsuitability for dry soils, I have not included timothy seed in the mixtures I have used for my light Cheviot hill land. At the same time, its value and suitability for moist and peaty soils should not be overlooked, and for these last-named soils I would recommend its use.

Italian Ryegrass (*Lolium italicum*), like timothy, is 25 per cent. less productive than the three grasses first treated of. Its value is well known, and, as regards its nutritive value, earliness, productiveness, and quickness of growth after it has been mown, it far surpasses the perennial ryegrass. But it should be used with great caution for permanent pasture, as it is a biennial, and, as in the case of perennial ryegrass, its excessive use would leave spaces liable, or rather certain, to be filled by weeds and worthless grasses. When, however, either in the case of permanent pasture or for temporary pasture to lie for four or more years, it is intended to take a hay crop the first year, then 2 lbs. or 3 lbs. of Italian ryegrass may be used in order to increase the hay crop.

Further observation has led me to the conclusion that to increase the hay crop, and also aid in holding up the clover and the crop generally, tall oat grass would be preferable to Italian ryegrass, as it is free from the defects of the latter, but tall oat grass is too expensive to be used on a large enough scale for increasing the bulk of the hay crop and holding up the crop, and I now think, that, say, 2 lbs. or 3 lbs. of Italian ryegrass should be added to mixtures for permanent or temporary pastures.

Perennial Ryegrass *(Lolium perenne)*, as the reader will see by reference to the table, is 30 per cent. less productive than the first three grasses on my list, and I have written so much on it previously that no further remarks on this grass are here required. I may add that, after a long experience, I am sure that, for the reasons previously given in this book, it does not pay to use it at all for permanent pasture, nor for temporary pastures which are to lie for four or more years. I am even doubtful whether it should be used for temporary pastures which are to lie for two or three years, but, if used, it should be sown in small proportion—5 lbs. or 6 lbs. to the acre.

Meadow Fescue (*Festuca pratensis*).—The merits of this grass are too well known to call for any remark here. Sinclair says that "it is much slower in growth after being cropped than cocksfoot," and this, of course, is the reason why in the table it stands as being 30 per cent. less productive. It thrives in good moist soils and its herbage is nutritive and liked by stock.

Meadow Foxtail (*Alopecurus pratensis*).—This grass, too, calls for little remark, as its merits are so well known, but "the weight of grass produced in one season is," we are informed by Sinclair, "considerably less than the amount to be obtained from cocksfoot," and that, of course, is why it stands, for productive purposes, 30 per cent. below that grass. According to Sinclair, "this grass, under the best management,

does not attain to its fullest productive powers from seed till four years," but later experience shows that the successful cultivation of this grass largely depends on the suitability of the soil and the sufficiency of moisture supplied. Thus at Carbeth, Killearn, Stirlingshire, meadow foxtail, sown in 1884 on a good stiffish loam, yielded in 1885 (the year following the sowing of the seed) such satisfactory results that it is stated of this grass by Dr. Wilson, in his able report, that "of all the grasses examined meadow foxtail seems to combine best productiveness and nutritive qualities." Though very valuable for permanent pasture, it is, however, not desirable for alternate husbandry.

I have now alluded to all the tall grasses commonly used for permanent pasture—*i.e.*, cocksfoot, tall fescue, tall oat grass, timothy, meadow fescue, and meadow foxtail—but there is a sixth of which I have had some experience, and which, for hay in especial, seems to me to be very desirable, *Poa fertilis*, or *serotina*, and Sinclair tells us that "it adds much to the value of a sward from its nutritive qualities and powers of early and late growth."

Fertile or late-flowering Meadow grass, (*Poa fertilis*, or *serotina*), has for a great many years been highly esteemed in the United States, and as it perfects an abundance of seed, and can therefore be easily propagated, it seems singular that it should have been neglected here. This grass is described in Dr. George Vasey's work, "The Agricultural Grasses of the United States," as *Poa serotina*, or fowl meadow grass, and he tells us that the culms are from 2 to 3 feet high (about the highest I have grown them here), and that there are some mountain forms, or varieties, which have culms only 1 foot or less in length. Mr. J. T. Gould, of New York, is quoted by Dr. Vasey as having found it to grow in almost every kind of soil, but as attaining its greatest perfection in a rich moist one. Professor Phares, of Mississipi (quoted by Dr.

Vasey), writes that "in portions of the Western States this grass has, for some years, been very highly recommended," and that "in the Eastern States it has been cultivated for 150 years or longer, and highly valued." Jared Elliott, writing in 1749, spoke of it as growing tall and thick, making a more soft and pliable hay than timothy, and better adapted for pressing and shipping for use of horses on shipboard. He says that it never becomes so coarse and hard, but the stalk is sweet and tender and eaten without waste, and another writer quoted by Dr. Vasey, Mr. Charles L. Flint, testifies to the same effect. The tenderness of the stems is most remarkable. On one occasion I had sheaves of this grass cut in a thoroughly ripened state, as the grass was grown for the sake of the seed, and yet my cows ate up with relish every part of the grass after the seed had been threshed out. The stems, however dry, are so tender that they break asunder with a slight twitch of the fingers. The grass, when allowed to grow tall, and by itself, is so tender that it is liable to be laid by wind and rain, but if it were mingled with a sufficient proportion of timothy to keep it erect I see no reason why it should not be then grown for hay.

Rough-stalked Meadow grass (*Poa trivialis*) is well known to be a very valuable grass in certain situations, and, after writing at length on it, Sinclair concludes "that the *Poa trivialis*, though highly valuable as a permanent pasture grass on rich and sheltered soils, is but little adapted for the alternate husbandry, and unprofitable for any purpose on dry exposed situations." Elsewhere he says that on such situations "it yearly diminishes, and ultimately dies off, not unfrequently in the space of four or five years." As regards productiveness, a reference to the table will show that it stands at 60, or 40 per cent. less than the first three grasses given. But notwithstanding what Sinclair has said—and I need hardly say that I differ with him with

great diffidence—my most recent observation of it, in the case of a dry and rather exposed situation, is that it is a valuable grass, for, though easily affected by drought, it revives again with great rapidity when rain has fallen, and, from its spreading habit, is valuable for filling up the bottom of a pasture in any situation. In the case of a pasture in its fourth year, and which occupies the dry and rather exposed situation alluded to in the last sentence, it shows no sign of decline, and I have therefore no hesitation in recommending it for pastures in any situation that are to lie from four to six years in climates resembling the driest parts of Roxburghshire.

Golden Oat grass (*Avena flavescens*) is valuable for filling up the bottom of a pasture, and also for its hardy qualities and suitability to almost any kind of soil. Being one of the smaller grasses, its productive powers are not large, but as the flowering stems are long (about 2½ feet), it would therefore yield fairly well in the hay crop. It stands in the table at 55.

Smooth-stalked Meadow grass (*Poa pratensis*) also stands in the table at 55, but is so decidedly condemned by Sinclair and other writers that I have given up sowing it, though, as the reader will remember, I used 2 lbs. of it in the mixture which, in 1895, gave such satisfactory results, due no doubt to the better grasses in the mixture.

Hard Fescue (*Festuca duriuscula*) is a grass which has been favourably spoken of by most writers on grasses. Sinclair considers it to be "one of the best of the fine, or dwarf-growing, grasses." "It springs rather early, and the produce is remarkably fine and succulent." He elsewhere observes that it withstands the effects of severe dry weather better than many other grasses. Its productive powers are inferior, and are stated in the table at 50. It is, however, useful for filling up the bottom of a pasture, and it is a drought-resisting grass.

Sweet Vernal grass (*Anthoxanthum odoratum*) stands

at 50 in the table. Sinclair considers that its early growth and hardy and permanent nature uphold its claim to a place in the composition of all permanent pastures; but, as its seed is scarce and dear, its use cannot be recommended while there are other grasses which have superior qualities, and are much cheaper.

Crested Dogstail (*Cynosurus cristatus*).—The productive power of this grass is small, and the reader will perceive that it stands at 45 in the table; but Arthur Young speaks highly of it, and so does Sinclair, and he goes so far as to say that "a sward of the best quality, particularly under circumstances where sheep are a principal object, cannot be formed without an admixture or proportion of the crested dogstail grass." It has the merit of being very drought-resisting, and it thrives well on dry lands. Many farmers dislike it on account of its wiry culms, but there can be no doubt that it is useful for filling up the bottom of a pasture.

Wood Meadow grass (*Poa nemoralis*), as regards productiveness, stands on the same level as crested dogstail—*i.e.*, 45—in the table, and Sinclair says that "the early growth of this grass in spring, and its remarkably fine, succulent, and nutritive herbage, recommend it strongly for admission into the company of the superior pasture grasses." But I cannot find that it is ever spoken of as a good drought-resisting grass; and, though it may be very suitable for lawns or pleasure grounds, the practical farmer would, I think, rather see any space that might be given to it filled with a safer grass.

Fine-leaved Fescue (*Festuca ovina tenuifolia*) stands last on the table, with a productive power as low as 40. It grows and thrives on mountain pastures, and is valuable in lawn mixtures, but should never be included in mixtures for laying down any kind of pasture.

Nerved Meadow grass (*Poa nervata*).—This grass cannot be obtained from seedsmen in this country, and I had some difficulty in procuring seeds from North America. From these I grew a certain number of

plants, some of which are growing here now. I have not paid much attention to this grass; but Sinclair evidently did, as he says that it is a remarkably hardy grass, and that "it possesses very valuable properties, and will be found a valuable ingredient in permanent pastures, where the soil is not too dry, but of a medium quality as to moisture and dryness." With reference to its hardiness, the writer said that "in February 17, 1814, after the severe winter preceding, this species of *Poa* was perfectly green and succulent, while not one species of grass, out of nearly 300 different species that grew around it, remained in a healthy state, but were all inferior, and more or less injured by the severity of the weather." I have elsewhere dwelt upon the obvious advantages of confining our attention as much as possible to the cultivation of the most hardy grasses, which, of course, are much safer for the farmer than the less robust kinds, and I hope that the mention I have made of the matter may induce seedsmen, and others interested in this important subject, to devote some attention to *Poa nervata*.

The clovers used by me at Clifton-on-Bowmont are :—

Late-flowering Red Clover (*Trifolium pratense perenne var.*).—The best form of red clover for my system, combining the qualities of permanence, productiveness, and the capability of resisting drought to a greater degree than any other red clover with which I am acquainted. I have used this variety extensively for nearly twenty years, and it has never failed. Its value as an accumulator of nitrogen from the atmosphere is second to none, and I think it one of the most important plants in my system of farming.

White or Dutch Clover (*Trifolium repens*).—Too well known to call for remark.

Alsike, or Swedish Clover (*Trifolium hybridum*).—Although neither deep-rooting nor drought-resisting, the Alsike clover is of too great value in a temporary

pasture to be left out. It is very hardy, but grows little in a drought.

I now proceed to remark, lastly, on various plants which may be usefully added to grass and clover mixtures.

Chicory and burnet, having been fully treated in what I have written previously (*vide* Chapters IV. and VI.) require no notice here.

Kidney Vetch, or Yellow Sand Clover (*Anthyllis vulneraria*).—This is a very valuable plant, and of supreme importance in a severe drought. In 1899 there was a very severe drought, and yet we cut 2 tons of hay per acre from the Big Countridge field, which, from a distance of many miles, looked like a veritable oasis in a desert of scorched hills. For the crop we were mainly indebted to the kidney vetch, which, after cutting, was almost entirely killed, but it had saved the situation, and its immense rootage, covered with nitrogen-collecting nodules, would no doubt tell favourably on the grass and subsequent crops. It is generally supposed that the kidney vetch never stands cutting, but Hayhope Shank field was hayed in 1897, and a small portion of the field, which was again hayed in 1900, showed a fair proportion of the plant. The Big Haugh field was sown in 1893; 2 lbs. chicory, 3 lbs. burnet, and 2 lbs. kidney vetch were included in the mixture. The field was hayed the first year, and was ploughed for turnips end of 1900. A strip was left unploughed along the fence side on the margin of the Bowmont, and in 1901 (eight years after sowing) this showed plenty of chicory, burnet, and kidney vetch. This seems to show that under certain conditions the durability of the kidney vetch is greater than is sometimes supposed.*

Yarrow (*Achillea Millefolium*).—The value of this plant for permanent pastures has been well known for

* From inquiries I have made the kidney vetch does not seem to thrive on rich soils. Such is the opinion of an experienced tenant here, and also of the agent of my King's County property in Ireland.

a long period, and therefore requires no detailed notice. Arthur Young, from what he has written, evidently had a high opinion of it. It will be observed that Mr. James Hunter, of Chester, thinks ¼ lb. of it sufficient, and perhaps this may be so in the case of permanent pasture, as the plants spread gradually; but in the case of pastures to lie for three to six years, and which are then to be broken up, I think that ½ lb. to 1 lb. should be used, as it is desirable to have a good supply of this plant quickly established in the land—partly as food for stock, and partly to insure a large root-growth in the land, so as to furnish much vegetable matter when the pasture is again brought into arable cultivation. For such temporary pastures I have used 1 lb., and do not find it too much. I have been particularly struck with the value of yarrow in seasons of extreme drought, and, in the case of the East Countridge field, I remember observing to my steward that were the yarrow removed the field would have had a totally different appearance, as it was the yarrow alone that maintained the green appearance of the field. In permanent pastures where the land happens to be very favourable to the growth and spread of yarrow, care should be taken to eat it close down early in the spring, or it will occupy the land to an injurious extent, and so, as I have found, injure a pasture. I was particularly struck with this in the case of a pasture let by me to a cow feeder. The tenant had no sheep to eat the yarrow down, and the yarrow was also allowed to seed, and the result was that the pasture has been distinctly injured—in fact, the yarrow, in some places, spread so thickly over the ground as to strangle both the grasses and clovers. Had the yarrow been kept down by sheep, it seems impossible, judging by my other pastures, that such a result could have occurred.*

* The proportion of yarrow in this field has since declined and does not now (1907) seem much in excess of the amount desirable. Perhaps the field has become yarrow sick. There is a theory advanced in Fletcher's

Lucerne (*Medicago sativa*).—On light, dry, or chalky soils, in the south of England, the lucerne is of great value as a deep-rooter and drought-resister, but it seems to be unsuitable to our soil and climate, and now I do not use it at Clifton-on-Bowmont, but for seed mixtures put down on my system on light, dry, or chalky soils in the eastern and southern counties of England I would advise the use of about 2 lbs. per acre. It has been recommended by Sir John Lawes to be used when laying down land to permanent grass, and 2 lbs. an acre may be added to the seed mixtures for that purpose.

Sainfoin (*Onobrychis sativa*).—Like lucerne, the sainfoin is unsuited to our soil and climate, and I am therefore prevented from making use of this valuable forage plant, but on chalky soils in the south and east of England it should prove a very desirable addition to seed mixtures formed on the Clifton Park system.

Birdsfoot trefoil (*Lotus corniculatus*) calls for some remark, as it appears in seedsmen's lists and mixtures, though, from Sinclair's account of the plant, neither it nor *Lotus major* seem to be deserving of attention. Sinclair says that "they are greatly inferior to the clovers. The white clover is superior to the common birdsfoot trefoil in the quantity of nutritive matter it affords, in the proportion of 5 to 4. It is much less productive of herbage." Altogether, there seems to be no good reason for cultivating this plant.

Sheep's Parsley (*Petroselinum sativum*).—I generally put down 1 lb. with my seed mixtures, as it is supposed to be favourable to the health of sheep.

Cotton grass, or draw moss (*Eriphorum vaginatum*).—This, though called a grass, is a sedge which thrives best in peaty lands. Its effect on sheep are so remarkable that a little space may be profitably devoted to it

"Soils," that plants sicken in a soil in consequence of the excreta from their roots, and it is possible that this may have been the case with the yarrow in question.

for the benefit of pastoral farmers, and with the view of suggesting means for increasing it. A neighbouring proprietor, who is also a practical farmer, has sent me a bundle of letters from correspondents of practical experience in the moorland farms, and also an account of the proceedings of the Teviotdale Farmers' Club, where the subject of this grass was discussed and its merits generally admitted. One of the correspondents alluded to says that the value of a hill grazing is greatly enhanced for blackfaced sheep if there is a good supply of draw moss on it, and that it has a special value in the spring months, though the sheep eat it all the year round. In a very open spring he has seen the blackfaced sheep mellow in the skin and flush in condition on account of their having had a good supply of draw moss. Another correspondent writes that it is invaluable for lean sheep in a backward spring, and rapidly brings them forward. It is a common saying that a good draw moss year is a good sheep year. A third correspondent points out that, especially in bad seasons, its presence or absence on a hirsel (sheep farm) makes all the difference between being well or badly lambed. None of the various correspondents have ever heard of an attempt being made to increase the supply of this highly valuable sedge. One of them mentions that when some of the land on which it grew was burnt, the effect of this was to increase the supply of the plants, and a further experiment might be made as to the effect of burning in increasing the supply of this valuable sedge. So far as I can learn, wet ground is essential to the growth of this plant, and one of the correspondents alluded to alleges that it disappears on land which has been drained. Some plants were brought down from an elevation of 1800 feet on this property, placed in the garden and watered at Clifton-on-Bowmont, but they all died. The head gardener at Clifton Park writes as follows with reference to some plants sent here from the Lammermoors :—

"Plants of this grass were received here in July, 1901. At that time they were bearing seeds, and these were collected and sown in a soil consisting of peat and silver sand. The seeds germinated freely, and the young plants were kept in the seed box till April, 1902, when they were transferred to their permanent quarters. Some of the seedlings were planted in soil similar to that in which they were raised—*i.e.*, peat and silver sand; the others were planted in ordinary garden soil. All the plants were kept in these quarters till April, 1904. During the time they were under observation no difference could be detected between the plants growing in peat and those in ordinary soil. Both plots were well supplied with water. Had it been otherwise those plants in the ordinary soil would possibly have suffered more from drought than the others in the peat, as peat retains moisture longer than ordinary garden soil."

These plants have now been transferred to the observation squares in permanent pastures. It seems likely that this valuable sedge could be readily extended by hurdling off pieces of land where the sedge is thickly distributed, and until the seed had been blown away by the wind. It is probable, from the behaviour of the plants here, that they would flourish in any marshy ground, even though it were not of a peaty character.

I have now noticed all those plants which I think of value for laying down land to temporary or permanent pastures, or improving hill pastures, and trust that the remarks I have made on them may be of some use to the farmer.

In the Appendices will be found some interesting and valuable information contributed by Mr. James Hunter, the well-known agricultural seedsman, to whom, in the Preface, I have fully acknowledged my obligations.

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CHAPTER VII.

WHY GOVERNMENT EXPERIMENTAL FARMS ARE SO SPECIALLY NEEDED, AND THE LINES ON WHICH THEY SHOULD BE LAID.

"People unacquainted with Agriculture quite forget that land is a destructible material, and its productive powers more easily squandered than a pocketful of loose guineas."—LORD DUFFERIN.

IT is well known that, with but few exceptions, agriculturists will not read, and are, indeed, averse to any form of intellectual exertion. This is not peculiar to farmers. I have found it the same in the case of my brother planters in India. The chief explanation of this is that, as a rule, the brightest members of families who have to earn their bread are sent to the professions and the public services, and the remainder to pursuits where no examinations have to be passed, and which do not call for intellectual activity. The natural result, then, is that a lad goes into, or is bred on, a farm, learns the routine that goes on there, and nothing outside of it, for anything outside of it would require that intellectual activity for the want of which he was sent to farming. For a time this answers fairly well, for every farmer gradually acquires a considerable amount of valuable practical knowledge which is suitable to existing conditions. But let any change in the times occur which demands a new system, or important modifications in the old one, and the farmer who knows nothing outside

of the routine he has been drilled into is liable to be, and often is, in a very helpless condition in consequence of his want of general agricultural knowledge. Worse still, he is steeped into a thorough belief that the system he has learned is infallible, and therefore suited to any times—a belief which, of course, seals his mind against the intrusion of any new ideas. When discussing with a farmer the changes required by the times, and a need for a thorough knowledge of grasses, he pointed to an old pasture, and said, "I know as much as most of them, and yet I could not tell you the name of one of these grasses." "We are awfully ignorant," said another to me when I was alluding to that or some other farming subject. And the class to which I belong, the landlord class, is in much the same position as their tenants; rather worse, indeed, for the agricultural ignorance of the landlords consists of what theologians denounce as the worst form of ignorance—a desire not to know—as I have previously shown in the early pages of this book. When, lastly, we turn to the factor or land agent, we shall find that he is simply an estimable gentleman who goes round with a bag, and when he has filled it he has not the slightest idea whether he has done so with the legitimate interest of the soil, the capital of the tenant, or the capital of the landlord, or a mixture of all three. Nor does he appear to think it his duty to make any inquiries on the subject. For many years past he has filled it very largely with the capital of the landlord; and, indeed, this must have been so, or we should not have heard such numerous complaints of exhausted soil. This is simply another term for depleted landlords' capital, which, I need hardly explain, consists mainly of soil. Now, to make any progress in our agriculture in such a way as to enable it to grapple successfully with these difficult times, we must, first of all, take into account the mental condition of the three great classes engaged in land, and its management and cultivation, and adapt our educational methods in such

a way that the classes in question may not be called upon for any form of intellectual exertion. In other words, you must teach not so much by books and lectures as by practical illustration in the field, and such illustration must not consist of experimental plots, but of farms of moderate size, conducted on the lines that any farmer could imitate, though, of course, attached to such farms experimental plots might be formed, and used for educational purposes. It is the recognition of the absolute necessity for this practical teaching for classes connected with land that has induced the United States to start its extensive system of experimental farms, and until we do so we can never expect to make rapid progress with the agricultural changes called for by the times. It must be considered, too, that as time advances calls may arise for further and further modifications as communications develop throughout the world, and its produce is therefore brought more and more cheaply to our doors.

That such farms would be appreciated by farmers I have had the fullest practical evidence from the number of agriculturists who have visited Clifton-on-Bowmont, many of whom have visited the farm again and again; and the immense correspondence we have had, and which, of course, has arisen out of the work on the farm. We have had a fair proportion of Professors of Agriculture as visitors, but few landlords and land agents:* I suppose because the two

* The visiting list shows an improvement as regards landlords this year (1904). It is as follows:—Farmers, 60; landlords, 21; land agents, 6; agricultural professors, 8; seedsmen, 8; schoolmasters, 5; ministers of the gospel, 2; agricultural chemist, 1; farm manager, 1; baker, 1; butcher, 1; shepherd, 1; ploughmen, 7 (the last are members of an agricultural educational class in the neighbourhood). Clifton-on-Bowmont farm is always open to visitors. The steward will show them round the farm, and he can supply from his books, when requested, all information respecting the seeding and cropping of the different fields for the last twenty years.

last classes are not sufficiently aware of the influence they might bring to bear in pushing forward the agricultural changes called for by the times, or perhaps that any changes at all are requisite. But the present "what we know we know, and what we don't know we don't want to know" attitude of these classes would be gradually changed were experimental farms placed within easy reach of a railway. One for the East and another for the West of Scotland would suffice to begin with, and the number required for England and Wales would not be large. I say nothing of Ireland, as that part of the Empire is safely in the hands of Sir Horace Plunkett. In this connection I may take the opportunity of thanking the Board of Agriculture for its action, though some might call it want of action, with reference to Clifton-on-Bowmont, in declining to take the part that I suggested with reference to the farm. This was that the Board should print a leaflet on the work of the farm, and send one to each County Council in order to make it known that the farm was open to visitors. The Department declined with thanks, on the ground that to do so would be to identify itself with a system—the system being as old as agriculture, though the method of carrying it out is on fresh lines. Judging by the number of visitors who have arrived without any aid from the Department, and who have, of course, taken up much of the time of my steward in showing them round the farm, it is evident that had the Department adopted my suggestion we should have been simply overpowered with visitors and correspondence, and I therefore take this opportunity, from a personal point of view, of thanking the Department, though it is not quite so clear that I have any grounds for doing so on behalf of the farming world. I may here add that I offered the Department, well knowing of what use my book would be in the Colonies, twelve copies, to be sent to the various Colonies, but they positively declined to move in the matter, which I partly mention

because the reader may be interested to learn that Mr. Chamberlain, though in the midst of all his Cape troubles, at once responded most cordially to a letter I very reluctantly wrote to him on the subject of sending the books to the Colonies, and undertook to forward them at once to the Australian Governors. I have also to thank the Board for refusing to support my proposal that the farm should be leased by the Government for a term of years, and carried on till the new system of farming had sufficiently made its way, as I now clearly see that where you have Departments with hardly any business men in them, the handing over of the farm to the Government would probably have done more harm than good, unless, of course, the services of Sir Horace Plunkett could have been obtained, or Mr. Chamberlain put in charge of the Department until it should be started on a sound basis.

The experience I have gained since the second edition of this book was published clearly shows me that whatever good the Board of Agriculture may be doing in some directions is far outweighed by the pernicious effect it has in misleading the farmer, and involving him further and further with the manure merchant. The teaching it is directly or indirectly responsible for is not as it, of course, should be, in the direction of that agriculture which stands firmly on its own feet, and shows the farmer how to depend on his own efforts for all, or nearly all, he requires. On the contrary, the farmer is taught that if he wishes to grow heavier crops he must go to the manure merchant, and that if he wants to produce more meat he must go to the manure merchant again. The Board may urge that it is not responsible for this teaching, and that it hands over the public funds to Colleges and other educational institutions; but is it not obvious that, on the *qui facit per alium facit per se* principle the Board is to blame for money being spent in a way that is really adverse to the agricultural interests of the country. This subject

is of such importance to the national interests, and especially in connection with the maintenance of the numbers of our rural population, that I enter here into some details to show that the present policy of the Board of Agriculture, and the methods of agricultural teaching practically approved of by it, are calculated to deplete still further our largely exhausted soils, and therefore still further reduce the numbers of our rural population.

In my paper read at Cambridge, I said (*vide* Appendix IX.) that the chemist must become more of a farmer, and the farmer more of a chemist, before either can work effectively in arresting the downward course of our British soils. And is it not obvious that if, when the blind lead the blind, the result is liable to be unsatisfactory, the leading of the semi-blind by the semi-blind is certain to end in much more serious disaster? In the former case both are proverbially liable to be abruptly aroused to the inadvisability of their proceedings, and that, too, before they have gone very far; but when a chemist who is agriculturally semi-blind leads a farmer who is chemically semi-blind, still more unsatisfactory results are, as we shall see, certain to ensue, for they are sure to be the means of doing much harm by the propagation of that most dangerous form of knowledge known by the name of half-truths. In order to prove this it is only necessary to look into the seventh annual Report on Experiments with crops and stock at the Northumberland County Demonstration Farm, Cockle Park, Morpeth. It is there evidently assumed that the British farmer has done all he can for himself by fully employing the natural resources within his reach, and that all that remains is for the chemist to step in and assist the farmer either to increase his crops or improve the condition of his animals by the aid of commercial fertilizers. But the chemist (though adding the name agricultural would lead people to suppose that he is an agriculturist as well as a chemist) really knows nothing of agriculture, and

indeed it is obvious that he does not, for otherwise he would first of all inquire whether the farmer does make a full use of all the natural resources at his disposal before advising that various kinds of chemical manures should be used. But the chemist makes no such inquiries. He takes British soil in hand as he finds it exhausted more or less by long courses of limings and artificial manures, and tells the farmer that all he has to do is to replace what he has taken out of the soil, and that if he wants more produce from it he must at once apply an increased supply of the chemical ingredients that have been carried off the land. By this process the chemist manures the plant and not the soil, while the farmer puts down as little as he thinks will serve to grow the plant, which he could not otherwise effectually do, and the plant, grown through this aid, searches through the soil to absorb the remains of its natural fertility. Thus the decline of our soils proceeds till the humus of the soil becomes so thoroughly exhausted that the diseases of plants increase, and they are more and more at the mercy of the vicissitudes of unfavourable seasons. Then as the fertility of the soil declines, and natural sources of plant food diminish, and are not replaced, or only in most inadequate degrees, by natural agencies, the artificial manure bill must be increased, and it has been so increased that farmers now complain that it amounts to another rent. But such manures, even if they could be had for nothing, would not enable the plants of the farmer to contend successfully with climatic shortcomings which so frequently occur in these islands—excessive drought, or excessive wet, or excessive cold. If the season is perfect the artificial manure will act fairly well. If it is too dry there may be too little water present to convey the plant food into the plant, and if very wet much of the manure may be washed away, and other parts of it, if not used at once, are liable to enter into insoluble compounds in the soil; while if the season is cold the artificial manure

cannot raise the temperature of the soil as humus does. It is evident then that what the farmer requires is at once a chemical and a physical agent provided at the lowest cost, which will act with the greatest certainty, no matter what the season may be, and which will continuously increase the humus of the soil, and add to its depth. This he can provide, as I have abundantly shown, by growing a turf of deeply-rooted, and powerfully-rooted plants. The chemist with his artificial manures can only provide, of course, a costly chemical agent which must always be, as I have shown, at the mercy of the season, and not only cannot permanently ameliorate the fertility of the soil, even in the most favourable seasons, but, unless supported by dung or turf, must deplete the soil. To the agriculturist who has what Locke terms "Large, sound, roundabout sense," the preceding statements are, of course, mere truisms; but as there are many of my readers who, to use Locke's words again, "have not a full view of all that relates to the question, and may be of moment to decide it," it is advisable to refer them to the statements I have made as regards the crops grown without manure, and also to allude to some facts with reference to the experiments made at Cockle Park County Demonstration Farm. These, as we have seen, are made on the assumption that the British farmer has done, and continues to do, all he can for himself, and that it only remains for the chemist to show him how, by the application of artificial manures, he may derive increased crops from exhausted soil. If the assumption is correct then the results of the experiments are valuable to the farmer, but the assumption, as I have abundantly shown at Clifton-on-Bowmont, is not correct, and the experiments are really only of value to show the farmer how, with the present low price for agricultural produce, he may lose his money if, after having adopted my system and manured his land with turf, he chooses to add artificial manures. The experiments made at Cockle

Park, in order to stimulate the seed hay crop with various manures from a cost of 13s. to 36s. per acre, show results which, as compared with my results from turf-manured land, are distinctly inferior, so that the farmer working on my system would have lost the value of the artificial manures had he used them. When I pass to the potato experiments at the College, as shown in its seventh annual Report, the results are still more striking. As shown in my paper delivered at Cambridge, Aug., 1904, I last year produced, without any manure other than turf, 13 tons 14 cwts. of potatoes per acre. With the aid of 12 tons dung and 6½ cwts. artificials, costing 101s. 1d., the College produced 13 tons 7½ cwts., and the College estimates that this manurial application brought in a profit due to manure of £23 11s. 2d. But how was this profit estimated? By comparing the yield with that of the no-manure section, which only produced 2 tons 16 cwts. But if this section had been coated with a deeply-rooted turf there is no reason to suppose, as mine is a poor land farm, that it would not have produced as much as the manured section, costing 101s. 1d. per acre, and it must be remembered that, when growing the turf, no expense other than that of the seed would have been incurred, while the hay and grazing obtained when growing the turf would, at a small cost, have yielded a handsome profit*—the average cost of the seed divided over the years when the turf was being formed coming to about 10s. a year—varying in occasional years with the goodness or badness of the grass seed crop, and the demand for seeds. From what I have shown it seems clear that the Board of Agriculture is really spending the national funds in teaching agriculturists how to farm at a loss.

* As it might be supposed that a good turf could not be grown at Cockle Park, as it is a poor clay soil, I would refer the reader to Appendix III., giving results of experiments on the Abbotsley poor clay soil with one of my mixtures, which has there produced a fine turf in four years.

These conclusions are confirmed by an experiment I made in 1901 in the Big Haugh field (*vide* Appendix III.), by which I lost about the rent of the land by adding dung and kainit to my ploughed-in turf. The manured section gave 15 tons of potatoes an acre, at an estimated cost for manure of £2 10s.; the turf-manured section gave 14 tons 6 cwt., estimating the potatoes at £2 per ton, the result was that we lost £1 2s., or about the rent of the land, from having used manures in addition to turf. This year (1904), which I am told is an inferior potato year as compared with last year, the potatoes, grown on Hayhope Shank Field East, show a decline to 12 tons 18 cwt. 4 lbs. on the manured section, and 12 tons 7 cwt. 1 lb. where the turf alone was relied on. It is interesting to note that these results had been obtained under much more unfavourable circumstances, as, from certain requirements on the farm, the rotation system in the case of this field was altered to oats out of grass, turnips, barley, and turnips, part of the field this year being allotted to potatoes, so that they were preceded by a cereal crop, then a turnip crop, and then by another cereal crop. As neither of the two cereal crops had any manure, and the turnips some artificials only, the crop of potatoes, may be considered to be the most satisfactory evidence of the great value of turf as manure, and especially of its lasting effects. It will be interesting to observe how, on the potato section of Hayhope Shank field, the grass will compare with that on the section in turnips. As yet, no difference can be perceived in the Big Haugh field between the grass after potatoes and the grass after turnips. But it must be remembered that the Big Haugh potatoes were taken out of grass, while those of Hayhope Shank were the fourth crop of the series, which no doubt accounts partially for the shortness of the crop. A fifth crop, a cereal one, will be taken next year, when the grass seeds will be sown along with it, and this crop will be taken without manure, so that the system will be put to a very

severe test.* The soil of the field is what is known as very light land.

I now turn to the sheep experiment at Cockle Park, as regards which the same misleading form of experiment has been repeated. The diagram illustrating the effect of the transforming hand of the chemist is really rather amusing. We start, as the advertisements of nourishing foods for the human animal do, at an extremely low standard, and the diagram shows first the figure of a small, melancholy, attenuated sheep, and no wonder, as he has been kept in the no-manure plot—poor worn-out land, growing no less than about 84 per cent. of wiry bent. But this attenuated sample of what may be done by a dietary of this description has its use in magnifying immensely, by contrast, the sheep in the remaining eight compartments which have been stimulated by the use of artificial manures, at costs varying from 22s. to as high as 61s. an acre. The portly figures of these sheep, as shown in the diagram, with the various manures inscribed on their sides, are really most encouraging at first sight, and show the results that may be attained by practically starving one sheep by keeping it on the toughest and poorest fare, and feeding others highly through the agency of costly manures applied to the soil. But how would it have been had the experiment been made on the Inner Kaimrig, which has carried a large sheep stock fed on a field full of dark green clover and kidney vetch, and which still, on November 12, presents a rich dark green appearance? I have no hesitation in saying that the attenuated sheep in Plot No. 1 of the Cockle Park experiments would have assumed a form as portly as his brethren on the manured plots, and yet on the Inner Kaimrig—originally the poorest field on a poor to medium land farm—no

* No difference could be perceived in the grass taken after potatoes, and the fifth crop (oats) was a satisfactory one, so that the lasting effects from land manured with turf has been proved beyond doubt.

manure, excepting some artificials with the turnips, has ever been used since the field was enclosed from the hill about 70 years ago, nor has any cake been fed on the land excepting some very trivial amount given to some rams kept in the field, and a few of the ewes drafted for sale—in fact, the amount of cake used on the whole farm is so small that the agriculturist quoted in my preface considered it to be practically none. But, for the benefit of the uninformed, I must add that it would convey an erroneous impression if I left him under the idea that my field had not been manured, and highly manured, and in a much more lasting form than the artificially-manured land at Cockle Park, on which the sheep experiments were made. For the Inner Kaimrig, as testified by the dark green herbage, has been heavily manured with nitrogen, partly taken from the atmosphere, and partly from decaying turf; while the deep-rooting plants have deeply cultivated the land, bringing up food from depths hitherto untouched, and manufacturing, by the acids in their roots, inert into active plant food. The humus has played its part, too, by converting into active plant food the dormant mineral constituents of the soil.

From what I have previously shown, it is evident that every experimental farm should be divided into two compartments—the one consisting of exhausted British soil, like that of Cockle Park, and the other of soil brought into a good state of fertility by natural agencies. It could then be ascertained whether it would pay the farmer best to carry on his exhausted soil on the present system, and aided by artificial manures, or whether it would pay better to alter the farming system in the direction of that adopted by me, and reduce his artificial bill to a low ebb, or perhaps abolish it altogether, as I have this year done in the case of one of my turnip crops. It seems obvious that if agricultural experiments such as I suggest are to be carried out, the present plan of employing what are

called agricultural chemists must be abandoned. What we require are practical farmers* who have acquired that moderate amount of chemical knowledge which constitutes the whole outfit of the existing so-called agricultural chemists, and which is all that is necessary on experimental farms of the kind I have suggested. Any intelligent farmer who has been farming on his own account for, say, about ten years, and of about 35 years of age, could learn the necessary amount of chemistry in six months, and the farms would then have agricultural chemists with a thorough practical knowledge of agriculture, instead of, as at present, chemists who have either none, or the merest smattering of it. It must be considered further—and this is a most important point—that farmers would be encouraged to visit such farms, and would thoroughly rely on what they saw there, were the operations conducted by a practical farmer.

I think it advisable, in conclusion, to give my reason for asking the Government to take a lease of my Clifton-on-Bowmont farm. It was partly to save time, and partly because of the poorness of the land, its originally-exhausted condition, and the nature of the climate, which is both very dry, cold, and much exposed to severe winds. With my system of farming I have brought much of the land up to a good state of fertility—good enough to produce good crops without

* Often the need for practical farmers at the Board of Agriculture has been conspicuously shown by the advice given by the Board to farmers, and a striking instance of this is afforded by their Leaflet, No. 168, entitled "Hints on the formation of Permanent Pastures." When all the experimental mixtures (*vide* p. 3 of Leaflet) had failed on the poor clays, excepting, as shown by the writer of the Leaflet, the mixture advised by me (which contained no perennial ryegrass), what is the use of advising the farmer to sow on such soils the mixture advised on page 4 of Leaflet, and if it has been proved up to the hilt for some 150 years back that perennial ryegrass is the worst of all grasses to put down in light soil, what can be the use of advising the farmer to sow on such soils a mixture containing a large proportion of this grass?

manure, other than that partly grown in the shape of turf and partly acquired from the atmosphere by natural means; but there is still enough land left which might be cultivated on the old system so as to form a comparison with the new system adopted. The farm consists of 1,250 acres, and the high land portion of it would be valuable for experimenting as to the improvements that might be effected on such mountain grazings. The Government, it is true, might acquire similar land elsewhere, but before the required comparison between the old and the proposed system could be instituted many years would be required to pass by—at least from 10 to 12—before the farmer could be able to judge as to the respective merits of the two systems. The Board of Agriculture sent an experienced official to report on the project, and he did so favourably, and I know that, besides, it was approved of by a prominent member of the Department; but nothing was done in the matter, which I now think is fortunate, as unless the farm were managed by a practical and skilful agriculturist, who had acquired the moderate knowledge of chemistry sufficient for the purpose, it could never be of the value it might become to the agricultural interests of these islands. I must not, however, be surprised at this want of action on the part of the Government in matters relating to agriculture, as its general policy seems to be to report, and do nothing but report. A Committee, as I have elsewhere shown, advised that a central seed testing station should be established where farmers could, for a small fee, get their seeds tested. This is a point of the greatest importance, and, indeed, absolutely essential to the system of farming I have initiated. The recommendation of the Committee was made in 1900, but so far nothing seems to have been done to carry it into effect. Nor, I fear, will anything be done which will aid in at once saving the agricultural situation, and arresting the decline in the numbers of our rural population, till a statesman can be found

patriotic enough to take charge of the Agricultural Department, and with enough energy and moral courage to compel the attention of the House of Commons to the requirements of British agriculture.

One word more. Any statesman can see for himself, by visiting Clifton-on-Bowmont, how great tracts of land now abandoned to pasture of a most worthless kind can be brought again under profitable cultivation with the aid of the system I have initiated; and how, therefore, the further abandonment of arable, with its consequent decline of our rural population, may be arrested. The more this subject is studied, the more clear does it become that the worst enemy of the rural population has been the British Government, and it will continue to be so until it follows the methods for the advancement of agriculture which have been adopted by all civilized Governments.

CHAPTER VIII.

THE PRINCIPLES ON WHICH A LANDLORD SHOULD FARM, BOTH FOR HIMSELF AND HIS SUCCESSORS.

IN order to collect votes for his party a politician, it is obvious, must be perpetually nibbling at something that he thinks will serve his ends. According to the Indian proverb the three great desires of man are, Hunna, Henoo, Munoo—money, women and land, and no doubt the party politician is not far wrong in selecting land as a convenient engine for creating party votes, and one of his chief reasons for doing so, of course, is that he can appeal to the plundering instincts which we have inherited from our remote ancestors, and which are but thinly varnished with a moderate amount of Christian doctrines, so thinly indeed that, under the pretence of doing justice to the masses the politician at once gathers votes for himself and advantages free of cost to his constituents, and blinds both himself and them to the nature of his actions when the rights of property are to be diverted, in a greater or less degree, for the benefit of others. There is always at least a chance of this being effected because unfortunately we have not, as the Americans have, the safe-guard of a written constitution. This, in their case provides such checks on any invasion of proprietary rights that it is certain that any Act at all resembling the Irish Land Act could not have been passed in America without an alteration of its written constitution, and the difficulties of obtaining this are so great that it may be regarded as practically unattainable.* For it has been laid down with great clearness

* To alter the constitution it is necessary to have a two-thirds majority of both houses and a reference to the constituents besides unmingled with any other matter than that for which an alteration in the constitution is proposed to be carried out.

by the wise framers of that constitution that every man is to be secured in his property unless it is required for a public purpose, when he is to have full compensation for it. Here, indeed, we are supposed to have a safeguard in the Crown and the House of Lords, but they do not feel themselves powerful enough to act as a restraining principle such as is effectively provided by the American constitution, and hence we see that property has been invaded in England, and is now liable to compulsory acquisition for the benefit of others, though this has been carried out in such a way as to make it appear that it is not so, the original landlord being still held on nominally as such, just as he is in Ireland, though deprived of nearly all his original landlord's rights over the land. Taking all these circumstances into consideration, it is of evident importance to show how a landlord should farm with the least risk both to his own interests, and those of his successor, for it would seem that a landlord can only be reasonably certain of retaining full possession of his land by farming it himself. The second point is of great importance, generally speaking, but would become of serious importance in the event of the successor being a minor, as though his guardians would have no difficulty in continuing my system of farming, and be able to do so at small risk of loss, the more expensive system of farming usually adopted could not be carried on without great probability of considerable loss in the case of unfavourable seasons. In the latter case the guardians would probably, or I may say certainly, let the land farmed by the minor's predecessor, to be possibly run out, as so much of the land has been in this country. For his own sake, then, and for the sake of his successor, the landlord should, in my opinion, adopt whatever system of farming will yield, and with the least probable risk, a fair rent for the land, interest on his floating capital at 3 per cent., and a steady increase in the value of the fixed capital—in other words, the fertility of the soil which, combined

with its equipment in the shape of buildings, fences and drains, is the fixed capital of the landlord. It has been my object in farming to attain such a system, as I have successfully done on my Clifton-on-Bowmont farm, which now yields rent, interest on capital, and shows a steady increase in the fertility of the soil. It is to the last that the landlord should attach the greatest importance, for, under my system, while the fertility increases the expenditure declines, as the land is ultimately more easily worked, and the seed mixtures may be cheapened, as less seed is required in the case of soil in fine condition. Weeds may be almost entirely prevented, and the crops will not only improve but, what is of great importance, be more able to resist the effects of unfavourable seasons, and can be grown successfully at much higher elevations, as is proved by this year's (1907) barley at Clifton-on-Bowmont, which is of very superior quality although grown in an unfavourable season and at an elevation of 750 feet.*

There is also another important consideration, and that is that the landlord must be on his guard against legislation inimical to his interests, and remember that the land he is cultivating may be acquired forcibly for small holdings, and that the more he spends on enriching his land through the agency of the present expensive system of farming, the greater will be his risk of loss in the event of the land being taken from him. And I may remark in passing that the same cautions apply to

* It is important to note that every time our soil is ploughed up at Clifton-on-Bowmont the land becomes darker from the increase of humus, and this means that the soil becomes warmer, and this again means that it becomes more fertile. In Fletcher's "Soils" the reader will find interesting facts in connection with the subject, and it is there stated "that a dark coloured soil is about eight degrees warmer near the surface than a light coloured soil. If the reader will compare what Mr. Fletcher has written in "Soils" on humus with my long practical experience at Clifton-on-Bowmont he will see that the conclusions I have arrived at exactly tally with those of the American Agricultural writers.

tenants holding above 50 acres of land who are now liable to be driven from their homes to make room for small holders.

It is of great importance that the landlord should farm the most inferior portions of his property in order, by his example, to show what can be done under the worst conditions, because it is obviously of the utmost importance to improve the inferior portions of the property, and lastly because this inferior land could only be profitably farmed on my system, and such land, even after being improved on my system, would not be at all suitable for small holdings. If he wishes, practically, to observe what can be done with poor run-out lands he has only to visit my Clifton-on-Bowmont farm, and contrast it with some of the farms adjacent to it which are being farmed on the old system. The improved system carried out on my farm may be briefly described by saying that it is one which (1) acquires all the manure possible from the air, (2) grows manure in the shape of deeply-rooted turf, (3) deeply stirs and pulverizes the soil by the agency of roots, (4) adds small quantities of artificial manures to stimulate growth, and so overcome the defects of an uncongenial climate, (5) adds small quantities of mineral manures when required, (6) obliterates all weeds, and (7) finally, employs such a combination of plants for growing turf as will at once improve the health and supply the greatest possible amount of food for stock, the largest amount of humus for the soil, and the deepest possible cultivation, and drainage of the land.

To elucidate my recommendations to landlords and others who, in my opinion, should farm in a way that will expose them to the smallest possible risk of loss combined with a steady improvement of the soil, I may make the following references to my Clifton-on-Bowmont farm. This consisted, when I took it over, of about 1,250 acres—about 450 arable, and the rest hill pasture, with hardly any heather on it. It carried throughout a

half-bred sheep stock—a breed resulting from Cheviot ewes crossed by Leicester rams. This breed is, comparatively speaking, costly to buy and feed, and I therefore substituted for it Cheviot ewes crossed with Leicester rams, thus selling half-bred lambs as before, but what is known as the first cross, and saving a considerable expenditure of capital—the difference in value between a Cheviot ewe and a half-bred one being about £1. This change enabled me to reduce the expensive and precarious turnip crop, as the half-bred ewes require a considerable supply of turnips—lessen the corn crop, and lower the labour bill.* The farm was previously worked on the five-course shift or rotation, *i.e.*, oats, turnips, barley, and two years in grass. This I changed to an eight-course rotation—turnips, oats, turnips, barley or oats with grass seeds, and four years in grass—a change which enables the farmer to put down an improved grass mixture at about the same annual cost as was incurred in the case of the five-course rotation, but yielding vastly superior results in grazing, and in the subsequent crops when the land is again brought under the plough. This eight-course system combined with filling up every space on the land with strong-growing grasses and plants, raised from pure seeds true to their kind—which are stronger than most weeds—literally obliterates weeds, and prevents others from growing — thereby, of course, saving the waste caused by growing weeds and the cost of removing them. On Clifton-on-Bowmont none have been removed for the last 16 years, and it

* It is important to remember that, though the demand for labour would be lessened on some farms by the adoption of my system of farming, it would be increased over the large areas of land now left in worthless pasture, but which could be restored to arable were my system adopted. It is also clear that much land might be taken from pasture lands, and turned into arable were my system adopted, though they could not be profitably worked in arable on any other system, and thus large additions may be made to the rural population.

would be difficult to find a cleaner farm. This system of cultivation also enables much more nitrogen to be taken from the atmosphere, for in our experience, after ploughing in the second turf, the red clover increases by about 25 per cent. It is hardly necessary to remind the reader that of all the nitrogen collectors red clover is certainly one of the best.

Though sheep are more profitable to the farmer than ordinary cattle (pedigree cattle breeding I am aware may be profitable), it is impossible effectively to graze, or, in other words, regulate the grass in pastures, with sheep alone, and this of course is especially evident when, as in my mixtures, the large grasses are almost entirely used, and therefore form such an extensive proportion of the pasture. The necessity for having a herd of cattle at hand is especially evident in the case of a warm and growing spring, which requires the grasses to be promptly kept down. If they are thus suppressed by being at once grazed with cattle, the whole pasture can be kept fine and even, and to the total exclusion of those unprofitable patches of long coarse grass which are too commonly to be seen in badly managed pastures, and which cause other parts of the pasture to be over closely grazed. The question to be considered now is as to what cattle the landlord should keep, and this, again, must be regulated by the guiding principle which, in my opinion, should regulate the policy of the landlord—economy of production. How this may be best effected must be left to the circumstances of each district, but as an illustration which may be of use to those farming land similar to Clifton-on-Bowmont, I may mention our practice there, where we have a herd of pedigree Galloways, to be crossed with shorthorns for the production of what are known as the "blue-greys." These having two coats are better able to stand exposure to weather, and are preferred by butchers to cattle of large size. Besides the Galloways we keep a small herd of pedigree shorthorns, partly for sale and partly for the

supply of bulls to cross with the Galloways. On such a farm as Clifton-on-Bowmont, which is permeated by small streams and shallow burns, ducks and geese may be economically kept, as they find much food for themselves. Turkeys are also kept, as when there is much grass they can find a considerable supply of food from the grass seeds. So far as I have been able to observe, the poultry yard does not receive the amount of attention that may profitably be bestowed on it. I need hardly say that I offer these remarks, not for the benefit of professional farmers who have been brought up to the business from their youth, but for those who wish to take to farming as an agreeable and interesting occupation, and who prefer a healthy country life to occupations of other kinds, and more especially for landlords who are, willingly or unwillingly, farming portions of their property. Neither of the last-named classes, I may repeat, should, in my opinion, farm on the same lines as professional farmers. One of these, an agriculturist of great practical experience, for instance, when he went over my farm before the change to Cheviot ewes, said that he would, had he had the farm, spend £500 a year on oilcake, and that he was certain it would pay to do so. Then, as regards the system on which the land should be farmed, I find a great difference of opinion, which shows how unsettled men's minds are as to what should best be done to contend most successfully with these varying times, when our agriculture is liable to be influenced by such a number of distant countries, which send us now much agricultural produce, and threaten to send us even increasing quantities. The reader will find in Appendix VI. the details of the system pursued as regards the stocking of the Clifton-on-Bowmont farm.

Before bringing this chapter to a close, I think that it is desirable to observe that there never was a time in our history when the landed interests in our country should be more carefully guarded, and every incentive

provided for full justice being done to the land by the landowners, for the conditions throughout the world are such that, taking into consideration the immense foreign competition, and the heavy burdens imposed on land, it is certain that no tenant will embark on those landed improvements which are so necessary for the welfare of the country. And even if the capitalist tenants were inclined to lay out money in landed improvements, the possibility of having their farms wholly or partially seized for the creation of small holdings, would be a sufficient check to any tendency they might otherwise have to lay out money on the land. I have said that there never was a time when more attention was required to be bestowed on what is still the biggest industry in the kingdom, and if we look forward to the progress of manufactures and mining in Asia, we shall find that the development of our agricultural resources is a subject which must be one of ever-increasing importance to our national welfare. People generally, and Englishmen in especial, have seldom any inclination to look ahead (as Cobden did when he said, "I have often thought what ugly ruins our mills will make"), more especially when doing so is at all likely to disclose a rather disagreeable prospect, but if it is desired to attract attention to the necessity for following American lines as regards state aid to agriculture, we should take into careful consideration our manufacturing and mining prospects. To look forward here with accuracy, it is both advisable and interesting to look back to the beginning of our manufacturing progress—to the time when machinery was introduced, and when, with the aid of protection (which levied import duties so high that we find the weavers of Bengal petitioning the English Government to be allowed to compete on equal terms with English manufacturers) the skill and capital of the West overcame the cheap hand labour of the East. Having established our manufactures with the aid of protection we then called out loudly for free

trade all round. But the skill and capital of the West have now gone out to ally themselves with the cheap labour of the East, and the numerous mills in India testify to the initial steps of the vast changes that are slowly but steadily advancing. But this is far from being all. The Japanese, the Chinese, and the native capitalists of India are rapidly learning all that Europe can teach, and, ultimately, will carry manufacturing and mining industries to the utmost limit attainable. Then will be seen the greatest labour struggle the world has ever beheld—the competition between the cheap dark and the dear white workman. When that period arrives, and it cannot be far distant, Calico may once more come to us from Calicut (a town on the West Coast of India), which gave its name to the cotton productions we once imported from the East, and if we wish to manufacture even for our own people it is plain that we should only be able to do so with the at present despised agency of protection. That resource alone will be left to us as far as cloth manufactures are concerned. The same remark will also apply to every other product which we now export. For the rest we must rely upon the development of our biggest industry—agriculture. What is Agriculture? As the Indian proverb goes, "the ploughers are the linchpin of the world." Pull it out and the whole machinery of life tumbles to pieces. Amidst the din of hammers, the whirl of machinery, and the tall smoking chimneys, we seem to have quite forgotten this fact. We shall once more have occasion to remember it, and perhaps sooner than we anticipate. It is of obvious importance then to set our house in order betimes, and prepare to furbish up our agricultural armour to the utmost. We have tried to do so by calling in the aid of costly artificial manures, and costly mechanism in the shape of subsoil ploughs, and other earth-stirring implements; we must now call in the appliances of nature in the shape of deep-rooting plants, which will at once till, manure, aerate and drain our soils with the

utmost degree of efficiency and economy. When an eminent agriculturist was one day looking at a field on my property laid down with the mixture of grasses used in my system of farming, and carrying a large stock of sheep at least double what can be kept on the old system under ryegrass and a little clover—he said "we have no idea of the stock this country could carry were this subject attended to," and if that is so, and in my opinion it undoubtedly is so, then the possible increase of the fertility of our soils through the agency of the vastly increased stock that may be maintained, far exceeds anything that could be conceived as possible under our present system of agriculture. What is its greatest defect? That it has no true rotation of crops and no self-acting manurial, drainage, and tillage system. What is a true rotation of crops, or, to put it in another way, what is that principle which ought to guide the farmer when he grows a rotation of crops? It is important to remember that crops of various kinds may be found on a farm, and that you may have a different crop every year for a series of years and yet be far removed from carrying out a scientific rotation of crops, *i.e.*, a system which will yield the best results to the farmer at the smallest cost, and the only effective way of carrying out the most profitable form of rotation lies in the cultivation of crops which take nitrogen—equal in the end to ammonia—from the air with those which can only derive it from the soil. In Scotland at least there is no such rotation excepting in those occasional cases where a crop of beans is grown. The only nitrogen collecting crop grown, or rather attempted to be grown, consists of the clover sown along with the grass seeds, and this clover is not only insignificant in amount, but is commonly a partial and often a complete failure. From a nitrogen collecting point of view then there is practically no rotation of crops at all, and never will be till, as is the case under my system, large crops of red clover and other nitrogen collecting plants are grown. When such

crops can be generally grown, and as I have proved under my system, can be grown with certainty, then, and not till then, will our agriculture be placed on a sound footing, and it will be on a sound footing because the greatest possible amount of manure will be derived free of cost from the atmosphere. With the aid of these agencies will be kept the greatest possible amount of stock on the land. This, of course, will enrich it with manure cheaply supplied, and evenly distributed free of all cost for placing it in the soil. With this agency, also, will be grown the greatest amount of vegetable matter in the turf, which will be ploughed down when the grass period of my eight course rotation comes to a close—turf enriched with four years' manure from the stock kept on the land. When this ample plant food, and, what is of even more importance, these ample physical conditions are supplied, the four succeeding crops of the rotation may be grown without any artificial manure excepting the small supply necessary to stimulate the growth of the turnips, and so to remedy the too often defective growing power of our climate. By this system we have an extreme economy of production, and it is only by this economy that our agriculture can be profitably continued in the face of the enormous competition coming on in ever-increasing severity from almost all quarters of the globe. But turn where one may, a universal agreement will be found as regards the essential point of all others in any soundly economical agriculture which will maintain and augment the fertility of the soil, and, for one instance, I may quote the very decided opinion expressed in America, which tells us that :—"In general agriculture in Illinois, whether it is grain farming or ordinary live stock farming, the growing of legumes is absolutely essential in any economic system which shall maintain the fertility of the soil."* When this principle is recognised and

* University of Illinois Agricultural Experimental Station. Bulletin, No. 94, Novr., 1905.

acted on there can be no more running out of land, chemically and physically, as there is at present, and fertility will continuously increase to the benefit of both landlord and tenant, and I need hardly add, to the general augmentation of the national welfare, and especially the increase of employment in the rural districts, for it is perfectly obvious to all experienced observers, that while we cannot look for any increase of the rural population from turning the present labourers out of their cottages, and getting rid of the farmers who employ them, in order to supply their place with small cultivators, we can look forward with certainty to an increased employment from my system of farming owing to land at present left in worthless pasture being again brought under the plough. We can, also, look forward to a considerable increase in employment when the afforestation of the country is taken seriously in hand. By its consequent effect on the climate and the general water supply, a great improvement will take place in those agricultural requirements which are so largely affected by climate; for what agricultural requirements are of more importance than tempered winds, and evenly distributed rainfall? Though, well knowing from a wide experience both here and in India of the great climatic effect of woods, I confess I have been repeatedly surprised in the case of our wind-swept Cheviot Hills at the marvellous climatic effect of a single strip of wood only about 100 yards wide. In this connection I may mention that even the effect of the shelter, described in Appendix V., has proved of great value. This has turned out to be most successful in the case of a small plantation where it was tried, and though it would be difficult to find even on the Cheviots a spot more liable to be swept by the fiercest gusts, the plants, now three years old, have, we think, grown better than any of the numerous plantations which have been formed on the estate during the last twenty years. From my experience of the value of

this shelter, I am sure it would pay a farmer to have a similar one, to be lifted and put down wherever required in the grass fields of his farm. The lower part, up to the height of a wire fence, might be blocked up with any material most easily obtainable, as, for instance, furze, old sacking, or any substance that would check the wind. Now that such an improvement can be made in our temporary pastures in the way indicated in this book, stock can of course be kept far longer on the pastures than was possible formerly, when the old-time "windle-strae" farmers knew of nothing but ryegrass and clover. And if stock is to be kept out both later and earlier in the season, it is evident that the provision of sheltering plantations is a matter of great importance.

But all such improvements, like most other improvements, require an outlay of capital, and the whole tendency of our legislative interference is against this. The landlord is averse to spend money when he finds that all recent, and all threatened legislation, tends to his disadvantage. The tenant, in turn, is naturally averse to laying out money on another man's land, because his interests and improvements are in turn liable to be injured by the laws with which he is threatened in the interest of the small holders which the Government propose to create throughout the length and breadth of the land. The interests of the landlord, then, are to be sacrificed to those of the tenants, and the interests of the tenants and their labourers to the small holders. Amidst this jungle of state-created interests which are supposed to be favourable to agricultural progress in general and the increase of the rural population, but which are evidently hostile to both, how can any advance be effected? Progress will undoubtedly be postponed for an indefinite period ahead till the people of the country generally are sufficiently experienced to understand that the pace of agriculture cannot be forced by legislative interference, and that, on the contrary, it is sure to be retarded by it, as it is

being retarded at this moment, and to the evident injury of the rural population. For is it not evident that the rural population can only be increased by the large areas of land now abandoned to worthless pasture being again brought under the plough, and worked on my system? And is it not equally evident that this can only be effected by capitalist farmers working on a comparatively large scale? There is here much room for an increase in our rural population. There evidently can be none by cutting off pieces from large farms for the creation of small holdings, as for every small holder put in you would have to drive out a labourer and his family.

So much has been said and written—and written especially in a misleading way—as to the nationalization of the land, that it may be well to devote to this subject the concluding pages of this chapter. It is remarkable, or perhaps it is not remarkable, that those who have advocated this system—notably John Stuart Mill and Henry George—absolutely ignore the fact that about two-thirds of the lands of British India are held from the State on 30 year leases, at the termination of which the land is revalued. In making this valuation, the unearned increment—*i.e.*, the rise in values from various causes such as facilities for communication, or a rise in prices—is claimed by the State, while a rise in value owing to the exertions of the occupier—in making wells, for instance, or other improvements—is not made a ground for increasing the assessment, or, in other words, the rent. Alongside of this nationalized land, we have what are called the permanently settled districts—in other words, where the owners of land have to pay a fixed rate of taxation which is not subject to any revision. Here, of course, the unearned increment goes to the landholder. At first sight, it would seem that the former system ought to answer nearly as well as the latter, with reference to the outlay of capital on the land. As a matter of fact, it does not do so, and obviously because there is an element of uncertainty connected

with the 30 year leases, for though the improvements effected by the occupier may not be assessed, the rise of rent on general grounds may be too high, so high as to nullify the fruits of the improvements, and instances have occurred where the assessment has been subsequently reduced. The proceedings of the government of the North-West Provinces and Oude afford clear evidence on this point, and it is shown that in the permanently settled districts there has been an immense progress in irrigation carried out by private enterprise, evidently in consequence of the certainty of the conditions as to taxation, and to the unearned increment being left to the proprietor instead of being absorbed by the State. The results of this have been conclusively shown with reference to famines, and in the proceedings of the government of the North-West Provinces and Oude (now the United Provinces), where the condition of things in the permanently settled districts has been contrasted with that in the temporarily settled, or 30 year leasehold districts—in other words, land-nationalised districts. It is stated that:—"Throughout the whole tract (*i.e.*, of the permanently settled districts) there have been occasional periods of agricultural distress, but it has always been in a mild form, and for a century famines such as have occurred in other parts of India have been unknown." The nationalisation of the land, then, has retarded private enterprise, and it will always do so however good the plans of the Government may be theoretically, and State meddling with land here, such as proposed by would-be land legislators, is sure to have similar evil effects. As one practical illustration is worth a score of general statements, I may quote the following letter written by me to my land agent, when the landlords of Ireland were deprived of their original rights by the Act of 1881.

"Dear Mr. Morison,

"I have received your letter of October 4th, forwarding five letters from the occupiers of my King's County Estate, re-

questing a reduction of rent, and, had the present Land Act not been passed, these letters would have received my careful attention, with the view of granting a reduction in those cases in which I, as a landlord, might, from motives of good nature (it is not pretended that there are any cases of distress on the property), be expected to make some concessions. But I should be glad if you would point out to the occupiers that, since the Act was passed, I have ceased to be the landlord of the Estate. The occupiers are now, in fact, no longer tenants, but part possessors of the soil, and the landlord is the Government, which has taken to itself all the powers formerly exercised by me. In other words, I am merely a rent-charger, or the holder of a mortgage on the property, and as all the rights of a landlord have been taken away, all the duties I formerly had have disappeared with them. Though an actual landlord for but a short time (viz., before the passing of the Act), I had, as you know, begun practically to acknowledge a landlord's duties, exactly as I do on my property in Scotland. I made, on your recommendation, a bog road at a cost of £125, for the convenience of the tenants and to employ labour in bad times, and I also ordered the construction of two cottages, from which I was to have no return whatever, and I had intended, year by year, to do what I could to improve the condition of the people on the property. But those who were formerly my tenants cannot be so unreasonable as to expect me, after having been deprived of all control over my property, to continue to act as I would have done had my rights been left undisturbed. We were formerly partners as landlord and tenant; but the Government, by taking to itself the position of landlord, and granting large possessory rights to the tenants, has broken up the partnership, and the occupiers of the estate are now simply people who owe me money, and I have no more to do with them than with any other persons who may happen to be in debt to me. The Land Act has formally declared that the occupiers must pay their rents, and if they have any reason to complain of the rents being too high they must go to their new landlord, or, in other words, the Land Court, which can raise or reduce the rent, without my being in any way consulted.

"It is very disagreeable to me to have to write thus; but, if an end has been put to all the former relations of landlord and

tenant, the occupiers of the property have to thank the Government for the result—that result simply being that you cannot take away a landlord's rights, and expect him to continue to act as if those rights had been left undisturbed.

"In conclusion, I should like to take this opportunity of informing the occupiers that I was much pleased with my visit to the property, with all the improvements they had carried out, and very agreeably impressed with those I saw and talked to; and that I only hope they may thrive as well under the rule of their new landlord (viz., the Government) as they appear to have done under the former lords of the soil.

"I remain, yours very truly,

"ROBERT H. ELLIOT."

"Clifton Park, Kelso,
10*th October*, 1881."

This letter was noticed in the *Times* through its correspondent in Dublin, my agent was applied to for copies for the guidance of proprietors, and their agents in Ireland, and the letter was published in full by the *Scotsman* as a warning to would-be land legislators, but as their folly is founded on invincible ignorance it appears to be beyond the reach of any remonstrance, or any practical illustration of the harm that is sure to ensue from their melancholy line of action. But the English have always been celebrated for their want of foresight, and their extraordinary power of shutting their eyes to the most obvious facts, as any one may perceive who reflects on the history of the Indian Mutiny, the Boer War, and that faulty Indian Educational system which is the real foundation of the present discontent among certain classes in our vast dependency. By the aid of our inherent strength, and a great waste of public money, we have indeed pulled ourselves out of immense national difficulties, but no expenditure of public money will ever be able to repair the material, social, and political evils which must arise if our would-be land legislators should be successful in the warfare

they are directing against the landed proprietors of Great Britain, and the best interests of the kingdom. You cannot eat your cake and have it, unless perhaps it should happen to be oil cake, and, strange as the statement may appear to a land-legislator with his eyes fast shut to the baneful side of his efforts, you cannot eat a landlord and have a landlord. In other words you cannot drive capital from these improvements—such as the planting of shelter belts for one instance—which the landed capitalists will alone effect, without most permanently fatal results. This elementary fact will, I fear, only be perceived by land-legislators when it is too late—too late, because all experience has shown that capital when once driven away from a business or a country (Ireland for instance) can hardly ever be induced to return.

The publication of this letter may seem premature, and I therefore quote from Mr. Ure (the Solicitor General for Scotland) the following passage from a letter of his to a correspondent, published in the *Scotsman* of November 22nd, 1907. He says:—"I personally would not deny to large farmers a fair rent court, and I have no doubt that when large farmers are agreed upon that topic, as small farmers now are, their wishes will be given effect to by the legislature."

Here we have a direct promise of the worst feature of Irish land legislation, the natural results of which are shown in the above given letter—*i.e.*, the cessation of landlord's improvements, and a complete severance of the old relations between landlord and tenant.

APPENDICES.

JAMES HUNTER, Chester.

APPENDIX I.

PAPER CONTRIBUTED BY MR. JAMES HUNTER,

Agricultural Seed Merchant, Chester,

Grass seeds of the various kinds commonly used for laying down to grass, greatly differ from each other in their appearance, size, weight, &c., and the quality of the seeds usually offered for sale varies to an extent far beyond what would be imagined. The necessity, therefore, for a Standard of Quality, by which the ordinary user of these seeds may, with a fair degree of certainty, judge the quality of the seeds he buys, is obvious. On page 151, such a Standard, applicable to the seeds of all the grasses, clovers, and other plants used in laying down land to grass, either for long or for short periods, is given.

In the first column of figures in the table will be found the percentage of germination that seed of any given species, of the highest quality, harvested in good condition in an average year, should possess. This Standard, it will be understood, is a high one; but it can be attained without real difficulty, and users of seeds should not be content with anything inferior. It should never be forgotten that seed of the highest germination is always the cheapest, and that the highest germinating seed is also almost certain to be the purest, so that true economy can only be attained by using the very best seeds. It must be obvious that the higher the percentage of germination of any seed, the greater its money value. One pound of seed germinating 90 per cent. will produce as many plants as, and of more vigorous growth than, 1½ lbs. of seed whose germination

is only 60 per cent., so that if the value of the former is 1s. 6d. per lb., the latter is dear at 1s. per lb. Such being the case, it is astonishing that many who use grass seeds do not think it necessary to take precautions to ensure that the seeds they buy shall be of good germination, although it is a matter of such importance to themselves, not only as regards the future success of the pasture, which is the chief consideration, but also because of the present pecuniary advantage. If users of Grass Seeds studied their own interests, they would buy none without an exact statement of the germinating power of each kind. All vague statements as to the seeds being of "proved germination," &c., are valueless; and, unless the exact percentage of germination is stated, it cannot be known by the purchaser whether the seeds are of proved good germination or proved bad germination.

The next point of importance in regard to the quality of any grass seed is the weight per bushel of the sample, *vide* second column of figures in the table. Than this there is no better evidence of quality, and provided the seed is new and free from admixture with seed of another species, the test of weight alone will affirm the good quality of any sample of grass seed. The variation in the weight per bushel of the seed of any single species of grass is very great, as the following instances will show:—Meadow Foxtail may weigh from 5 lbs. to 14 lbs. per bushel; Cocksfoot from 6 lbs. to 24 lbs.; Meadow Fescue from 10 lbs. to 30 lbs.; Perennial Ryegrass from 14 lbs. to 30 lbs.; and all the others in similar degree. The explanation of this is simple. The heaviest samples must consist entirely of heavy ripe seeds, free from all chaff and undeveloped non-germinating seeds, and provided such a sample of seed is new and sound, it cannot fail to be of the highest germination—say, 95 to 98 per cent. Seed of lighter weight per bushel is composed partly of heavy ripe seeds, partly of undeveloped seeds and chaff, and, in

consequence, the germinating capability of the sample must be comparatively low. The lightest samples may be composed entirely of undeveloped seeds and chaff, having a possible germinating capability of not more than 5 per cent. It must follow that the use of such low class seeds can only result in failure, disappointment, and serious loss.

The number of seeds in one pound weight has an important bearing on the choice of seeds for a grass mixture, as, owing to the great difference in the size of the seeds of the different species, it is impossible without this knowledge to allot the due proportion of each species in the mixture. The table on page 151 shows that while 1 lb. of one species may contain over 3,000,000 seeds, 1 lb. of another species may have not more than 75,000.

In the fifth column of figures in the table is given the average price of seeds of the finest quality for the ten years 1898 to 1907. This average is somewhat higher than the average for the ten preceding years, when a cycle of cheap years prevailed. As variations occur every year it is, of course, necessary to ascertain the prices of seeds at the time they are required.

To produce a good seed mixture at the least cost, the sixth column of figures in the table should be studied. This column shows that the average cost of 1,000,000 germinating seeds of Timothy grass is 4¼d., while 1,000,000 germinating seeds of Tall Oat grass is 8s., although the average price per lb. of these seeds is respectively 5½d. and 1s. It is obvious, therefore, that the price per lb. of the seed does not convey a clear idea of its real cost, but that the cost per million germinating seeds does. The natural deduction from a study of the cost per million seeds is, that taking all the circumstances of soil, situation, and climate, the duration of the pasture and the requirements of the farmer, into consideration, the freest use of the cheapest seeds suitable to the requirements, should be made. It should

not be forgotten that the price of a seed is not arrived at because of its value to the sower. Its market value depends on the cost of its production, and the demand for it in relation to the supply. It follows, therefore, that a seed that is easily produced is cheap, and one that is not is dear; also, a small-seeded species, having many seeds to the pound, is cheap, while a large-seeded kind must be dear.

When seeds have been harvested under unfavourable conditions, or when there is a partial failure of crop of any species, the standard of germination for that species may be somewhat lower, and the price of the seed higher, so that due allowance must be made for such causes when they arise. It should also be borne in mind that the figures in the Table apply only to seeds of the highest standard of quality. Seeds of lower quality have a lower germination, are lighter in weight per bushel, have a greater number of seeds in 1 lb. weight, and, although cheaper by the lb., the cost per million germinating seeds is usually greater than that of the best seeds.

The illustrations of seeds used for laying down land to grass (*vide* plates facing page 152) will enable any one, who is willing to give some attention to the subject, to judge of the genuineness and purity of a sample of grass seed. These illustrations have been carefully prepared from micro-photographs of the different species. It must be evident, even to one who is not an expert, that any seed or other matter contained in any sample under examination which differs in shape, appearance, or character from the true seed, must be an impurity, and in order to ascertain the amount of pure seed and of the impurities, a separation of a given quantity should be made and the result noted.

STANDARD OF QUALITY OF SEEDS FOR GRASS MIXTURES.

Name of Species.	Per centage of Germination.	Weight per bushel.	Number of Seeds in 1 lb.	Number of Germinating Seeds in 1 lb.	Average price per lb.	Cost per 1,000,000 Germinating Seeds.
		lbs.			s. d.	s. d.
Alopecurus pratensis *(Meadow Foxtail)*	90	14	490,000	441,000	1 4	3 0
Anthoxanthum odoratum *(Sweet Vernal)*	80	14	738,000	590,400	2 0	3 2
Avena elatior *(Tall Oat-like Grass)*	90	16	138,000	124,200	1 0	8 0
Avena flavescens *(Golden Oat Grass)*	80	14	1,400,000	1,120,000	3 0	2 8
Cynosurus cristatus *(Crested Dogstail)*	95	40	886,000	841,700	1 5	1 8
Dactylis glomerata *(Cocksfoot)*	95	24	426,000	404,700	0 11	2 3
Festuca duriuscula *(Hard Fescue)*	95	24	578,000	549,100	0 8½	1 4
Festuca elatior *(Tall Fescue)*	96	24	246,000	236,160	1 3½	5 6
Festuca ovina tenuifolia *(Fine-leaved Fescue)*	85	28	1,561,000	1,326,850	1 4	1 0
Festuca pratensis *(Meadow Fescue)*	98	30	236,000	233,280	0 9½	3 4½
Lolium italicum *(Italian Ryegrass)*	98	23	270,000	264,600	0 3¾	1 2
Lolium perenne *(Perennial Ryegrass)*	98	28	223,000	218,540	0 3	1 2
Phleum pratense *(Catstail or Timothy)*	98	50	1,320,000	1,293,600	0 5½	0 4½
Poa nemoralis *(Wood Meadow Grass)*	88	26	2,325,000	2,046,000	1 9	0 10½
Poa pratensis *(Smooth-Stalked Meadow Grass)*	85	30	1,860,000	1,581,000	0 10½	0 6¾
Poa trivialis *(Rough-Stalked Meadow Grass)*	97	30	2,235,000	2,167,950	1 7	0 9
Achillea Millefolium *(Yarrow or Milfoil)*	90	38	3,510,000	3,159,000	4 9	1 7
Anthyllis vulneraria *(Kidney Vetch)*	98	64	193,000	189,140	0 11	4 10
Cichorium intybus *(Chicory)*	85	38	335,000	284,750	1 3½	4 6
Lotus corniculatus *(Birdsfoot Trefoil)*	98	65	412,000	403,760	1 3½	3 2
Medicago lupulina *(Trefoil or Yellow Clover)*	98	68	319,000	312,620	0 5½	1 5½
Medicago sativa *(Lucerne)*	98	65	224,000	219,520	0 11	4 2
Petroselinum sativum *(Parsley)*	90	45	230,000	207,000	0 6	2 5
Poterium sanguisorba *(Burnet)*	140	27	54,000	75,600	0 5	5 5
Trifolium hybridum *(Alsike Clover)*	98	66	718 000	703,640	1 0	1 5
Trifolium pratense *(Red or Broad Clover)*	98	66	232,000	227,360	0 10½	3 11
Trifolium pratense perenne *(Perl. Red Clover)*	98	66	218,000	213,640	1 0½	4 11
Trifolium pratense perenne var. *(Late-flow'g. Red)*	98	66	218,000	213,640	1 3	5 10
Trifolium repens *(White or Dutch Clover)*	98	68	732,000	717,360	1 1	1 6

ILLUSTRATIONS OF THE SEEDS USED IN LAYING DOWN LAND TO GRASS ON THE CLIFTON PARK SYSTEM.

On the plates following this page are shewn micro-photographs of the Seeds of the various Grasses, Clovers, and other plants used in the Clifton Park System. These illustrations will enable the reader to identify the different species of seeds, to form a judgment of the genuineness of a sample, and to detect any impurities it may contain.

When comparing samples of seeds with these illustrations, or the illustration of one species with another, the different magnifications (which are given below), of the various illustrations should be noted. The larger seeds are shewn six times their natural size, while the smaller seeds are magnified ten times.

		Magnification in diameters.
	PLATE I.	
Fig. 7.	Alopecurus pratensis (Meadow Foxtail)	6
,, 8.	Anthoxanthum odoratum (Sweet Vernal Grass) ...	6
,, 4.	Avena elatior (Tall Oat-like Grass)	6
,, 1.	Avena flavescens (Golden Oat Grass)	6
	PLATE II.	
Fig. 9.	Dactylis glomerata (Cocksfoot)	6
,, 10.	Festuca duriuscula (Hard Fescue)	6
,, 11.	Festuca elatior (Tall Fescue)	6
,, 12.	Festuca pratensis (Meadow Fescue)	6
,, 16.	Lolium italicum (Italian Ryegrass)	6
,, 13.	Lolium perenne (Perennial Ryegrass)	6
	PLATE III.	
Fig. 19.	Festuca ovina tenuifolia (Fine-leaved Fescue) ...	10
,, 20.	Cynosurus cristatus (Crested Dogstail)	10
,, 21.	Phleum pratense (Catstail or Timothy)	10
,, 22.	Poa nemoralis (Wood Meadow Grass)	10
,, 25.	Poa pratensis (Smooth-stalked Meadow Grass) ...	10
,, 23.	Poa trivialis (Rough-stalked Meadow Grass) ...	10
,, 26.	Poterium sanguisorba (Burnet)	6
,, 27.	Achillea Millefolium (Yarrow)	6
,, 28.	Cichorium intybus (Chicory)	10
	PLATE IV.	
Fig. 33.	Anthyllis vulneraria (Kidney Vetch)	6
,, 35.	Medicago lupulina (Trefoil)	6
,, 36.	Medicago sativa (Lucerne)	6
,, 31.	Trifolium hybridum (Alsike Clover)	6
,, 32.	Trifolium pratense (Red or Broad-leaved Clover) ...	6
,, 30.	Trifolium pratense perenne (Perennial Red Clover) ...	6
,, 29.	Trifolium pratense perenne var. (Late-flowg. Red Clover)	6
,, 34.	Trifolium repens (White Clover)	6
	Inferior Grasses sometimes found in Samples of good Species.	
	PLATES I., II. and IV.	
Fig. 18.	Aira cæspitosa (Tufted Hair Grass)	10
,, 2.	Aira flexuosa (Wavy Mountain Hair Grass)	6
,, 5.	Alopecurus agrestis (Black Grass)	6
,, 6.	Anthoxanthum Puelii (Puel's Vernal Grass) ...	6
,, 17.	Bromus mollis (Soft Brome Grass)	6
,, 15.	Bromus secalinus (Rye-seeded Brome Grass) ...	6
,, 14.	Festuca sciuroides (Squirrel-tail Fescue)	6
,, 3.	Holcus lanatus (Yorkshire Fog)	6
,, 24.	Poa annua (Annual Meadow Grass)	10

PLATE I.

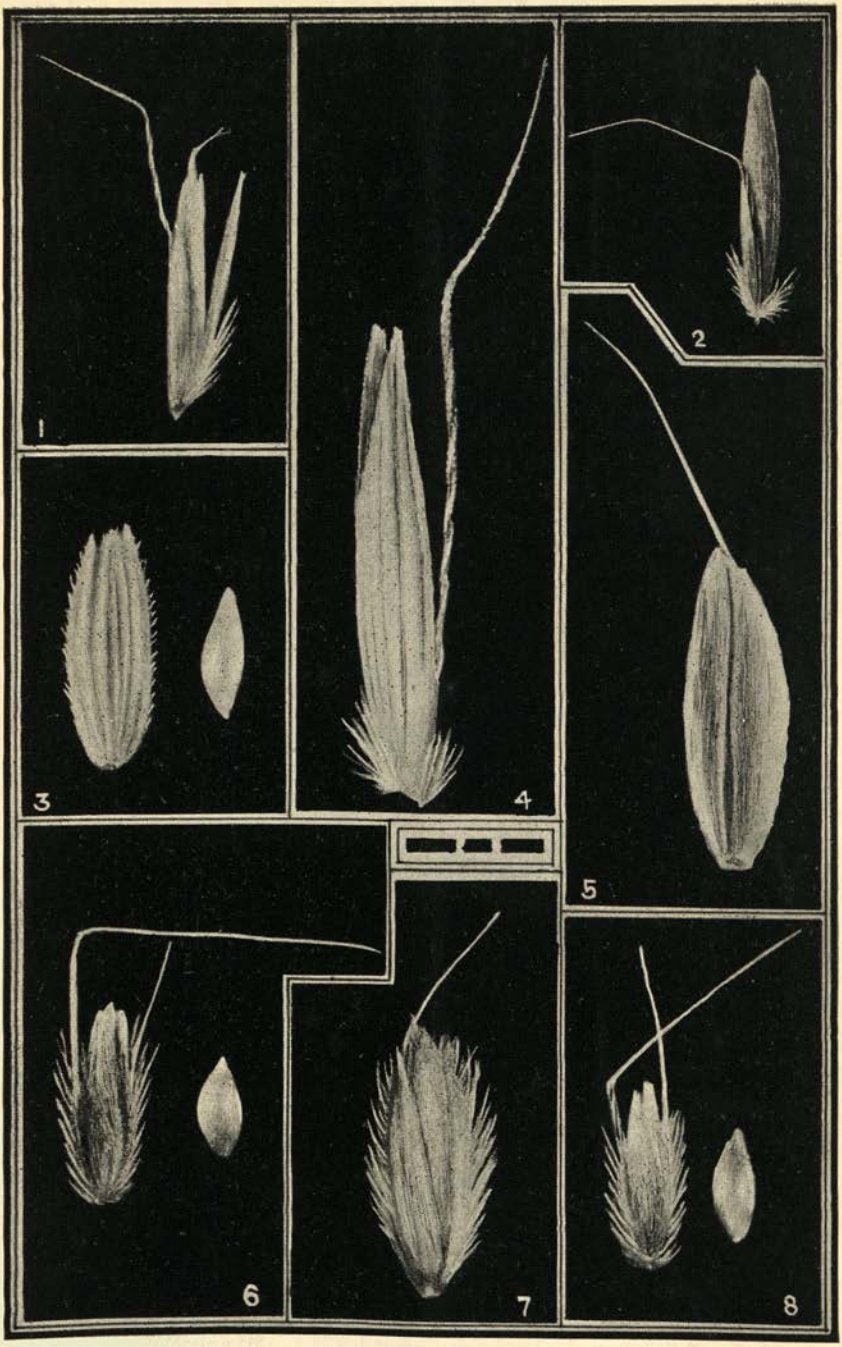

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PLATE II.

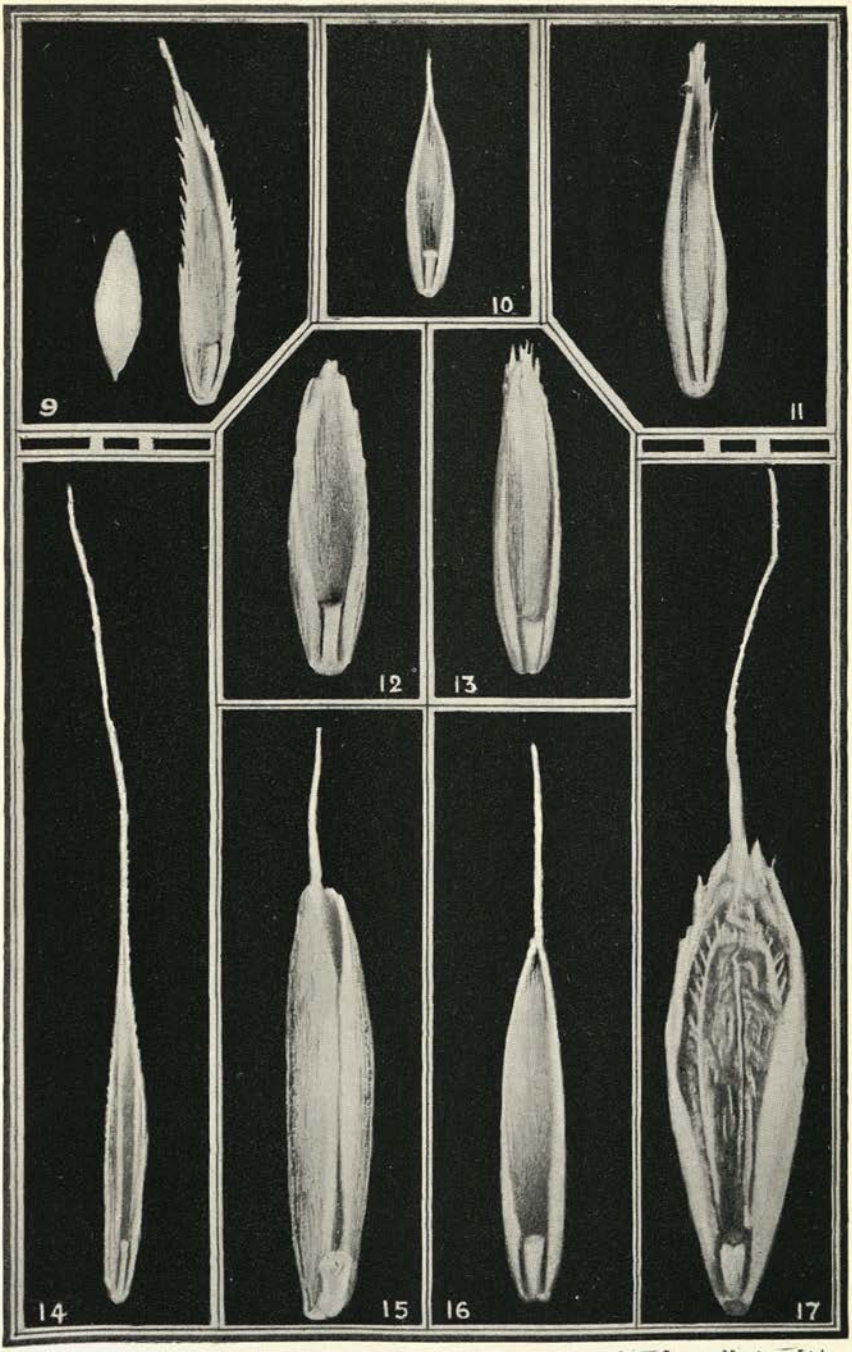

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PLATE III.

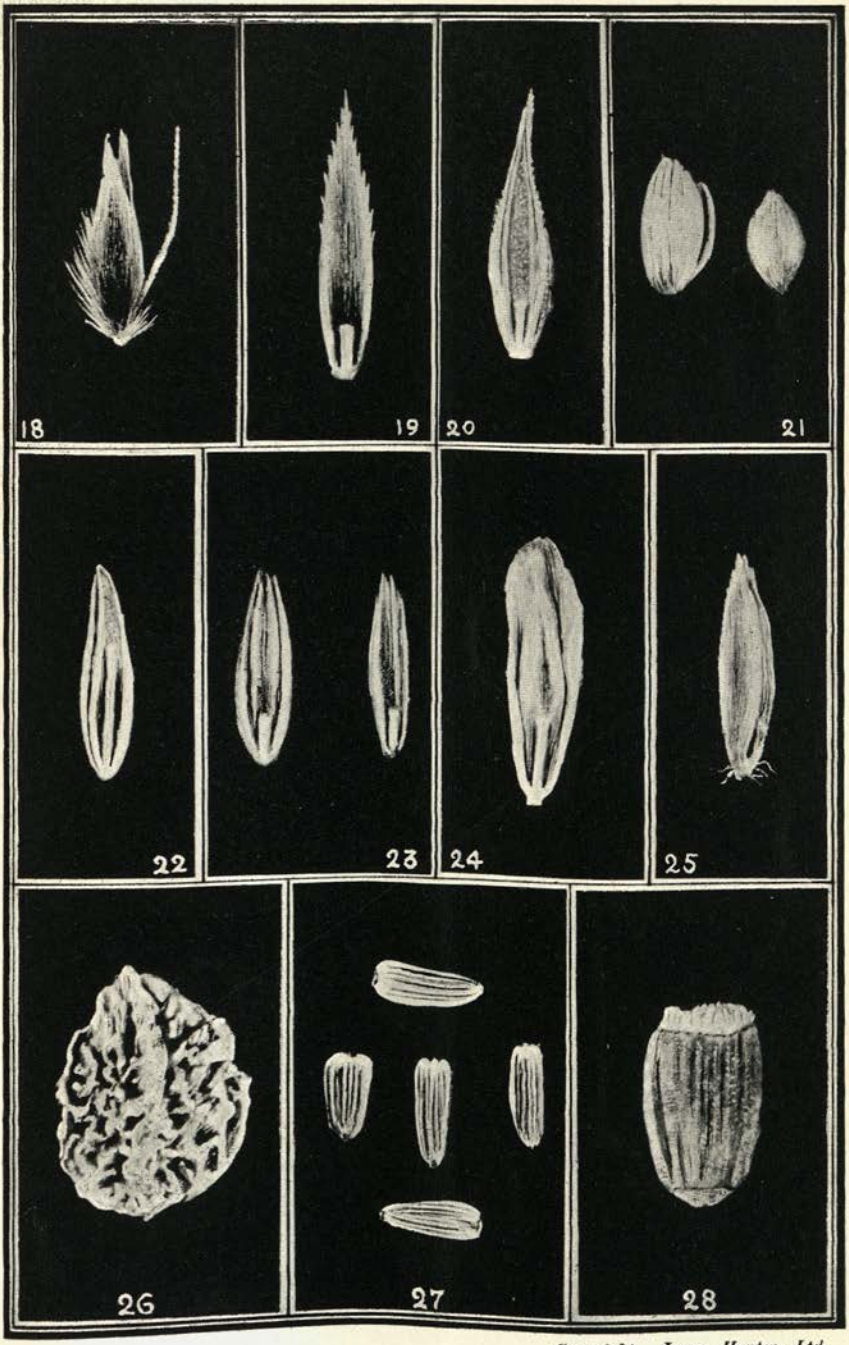

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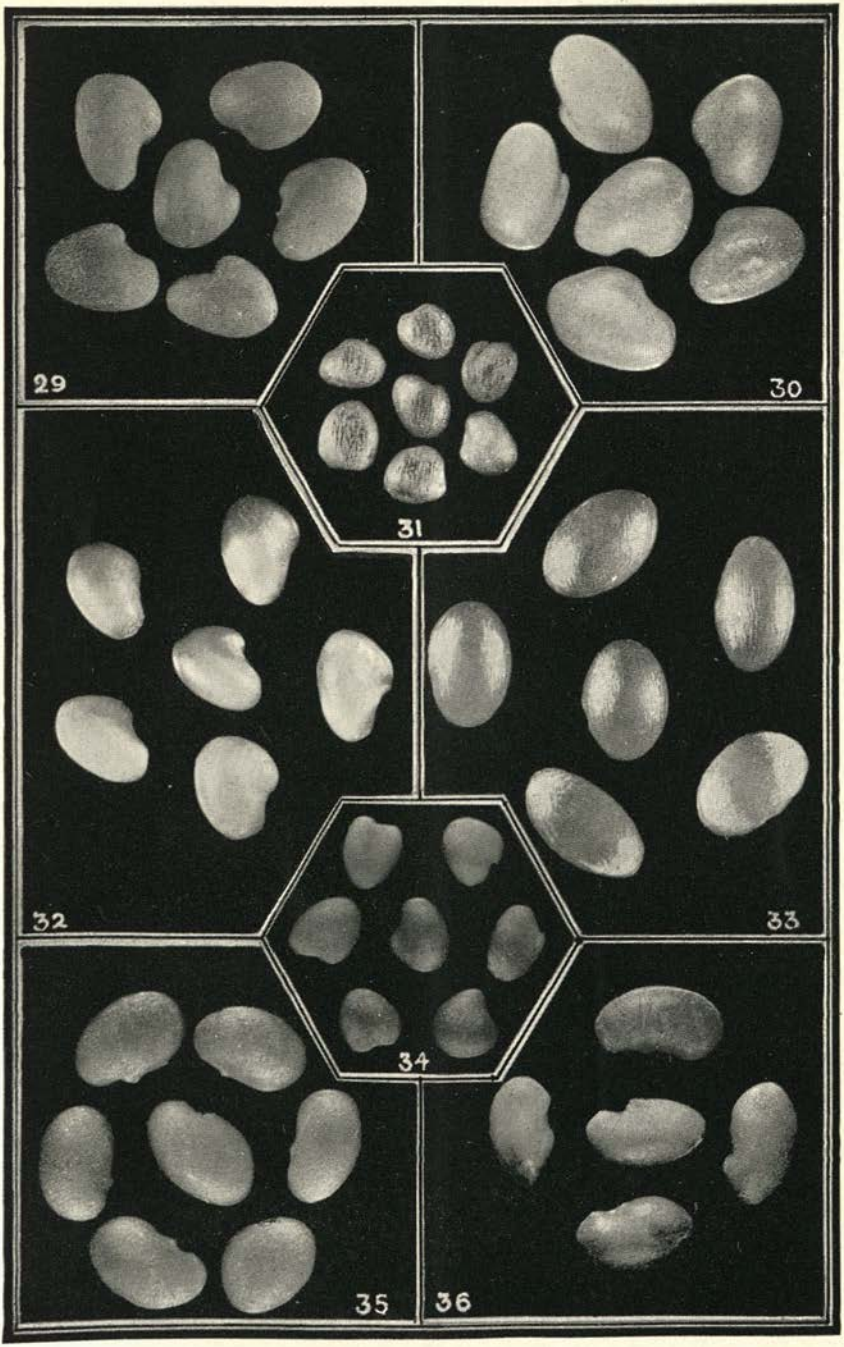
PLATE IV.



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The quantity of Grass and Clover Seeds (of the highest standard of germination and purity) sufficient to sow an acre of each species, the number of germinating seeds per acre, the average price per lb. for the 10 years 1898 to 1907, and the average cost of the seeds per acre:—

NAME OF SPECIES.	Quantity to sow a stat. acre.	Number of germinating seeds per acre.	Average price of seeds per lb.	Average cost of the seeds per acre.
	lbs.		s. d.	s. d.
Alopecurus pratensis *(Meadow Foxtail)*	32	4,112,000	1 4	42 8
Avena elatior *(Tall Oat-like Grass)*	56	6,955,200	1 0	56 0
Avena flavescens *(Golden Oat Grass)*	18	20,160,000	3 0	54 0
Cynosurus cristatus *(Crested Dogstail)*	30	24,719,400	1 5	42 6
Dactylis glomerata *(Cocksfoot)*	30	12,141,000	0 11	27 6
Festuca duriuscula *(Hard Fescue)*	36	19,767,600	0 8½	25 6
Festuca elatior *(Tall Fescue)*	50	11,808,000	1 3½	64 7
Festuca pratensis *(Meadow Fescue)*	56	13,083,840	0 9½	44 4
Lolium italicum *(Italian Ryegrass)*	48	12,700,800	0 3½	15 0
Lolium perenne *(Perennial Ryegrass)*	56	11,988,480	0 3	14 0
Phleum pratense *(Catstail or Timothy)*	16	20,697,600	0 5½	7 4
Poa pratensis *(Smooth-stalked Meadow Grass)*	16	25,296,000	0 10½	13 9
Poa trivialis *(Rough-stalked Meadow Grass)*	10	21,679,500	1 7	15 10
Achillea Millefolium *(Yarrow or Milfoil)*	8	25,272,000	4 9	38 0
Anthyllis vulneraria *(Kidney Vetch)*	24	4,539,360	0 11	22 0
Cichorium intybus *(Chicory)*	14	3,986,500	1 3½	18 1
Medicago lupulina *(Trefoil or Yellow Clover)*	20	6,252,400	0 5½	9 2
Medicago sativa *(Lucerne)*	24	5,268,480	0 11	22 0
Petroselinum sativum *(Parsley)*	30	5,865,000	0 6	15 0
Poterium sanguisorba *(Burnet)*	56	3,628,800	0 5	23 4
Trifolium hybridum *(Alsike Clover)*	12	8,443,680	1 0	12 0
Trifolium pratense *(Red or Broad Clover)*	16	3,637,760	0 10½	14 0
Trifolium prat. perenne *(Per. Red Clover)*	16	3,418,240	1 0½	16 8
Trifolium prat. per. var. *(Late-flowering Red)*	16	3,418,240	1 3	20 0
Trifolium repens *(White or Dutch Clover)*	12	8,608,320	1 1	13 0

The quantity of any species of grass required to sow an acre depends (1) on the size and weight of the seeds (these vary considerably in the different species—*e.g.*, *Avena elatior* has 138,000 seeds in a lb., while *Poa trivialis* has over two millions); (2) the size of the plant, and its surface-covering capacity: grasses of large growth, such as cocksfoot, or those of spreading habit like *Poa trivialis*, require fewer plants to cover an acre than those of small or upright habit of growth. It is important, therefore, to take these matters, as well as the price of the seed, into consideration, if economy in seeding is to be practised, as the seed that is the lowest in price per lb. is not necessarily the cheapest per acre, nor is the seed that is highest in price per lb. the dearest.

Estimate of the relative productiveness (quantity of grass produced in one season) of various species of Grasses, when grown on soils and under conditions best suited to the different species, arranged in the order of their productiveness :—

NAME OF SPECIES.	Estimated per centage of productiveness
Dactylis glomerata (*Cocksfoot*)	100
Festuca elatior (*Tall Fescue*)	100
Avena elatior (*Tall Oat Grass*)	100
Phleum pratense (*Timothy*)	75
Lolium italicum (*Italian Ryegrass*)	75
Lolium perenne (*Perennial Ryegrass*)	70
Festuca pratensis (*Meadow Fescue*)	70
Alopecurus pratensis (*Meadow Foxtail*)	70
Poa trivialis (*Rough-stalked Meadow Grass*)	60
Avena flavescens (*Golden Oat Grass*)	55
Poa pratensis (*Smooth-stalked Meadow Grass*)	55
Festuca duriuscula (*Hard Fescue*)	50
Anthoxanthum odoratum (*Sweet Vernal*)	50
Cynosurus cristatus (*Crested Dogstail*)	45
Poa nemoralis (*Wood Meadow Grass*)	45
Festuca ovina tenuifolia (*Fine-leaved Fescue*)	40

The recorded weights of the produce of small trial plots of grasses, made for the purpose of ascertaining their relative productiveness, show such diversity of results (probably owing to the smallness of the plots and the varying conditions of soil, climate, &c.) that they cannot readily be made use of for practical purposes. As, however, a general idea of the weight of herbage produced in one season's growth by each of the grasses used in laying down land to grass is necessary to the proper selection of seeds of the most profitable kinds, the above estimate is submitted, and, while absolute accuracy is not claimed for it, yet it may probably be accepted as presenting a fair view of the relative amount of grass each species is capable of producing when grown under the most suitable conditions of soil, climate, moisture, &c.

Grasses arranged in the order of their cost for seeds required to sow a statute acre, the prices upon which the calculations are based being those for the last ten years:—

NAME OF SPECIES.	Quantity to sow a stat. acre.	Average price of seeds per pound.	Average cost of seeds per acre.
	lbs.	s. d.	s. d.
Phleum pratense (*Timothy*)	16	0 5½	7 4
Lolium perenne (*Perennial Rye-grass*)	56	0 3	14 0
Poa pratensis (*Smooth-Stalked Meadow Grass*)	16	0 10½	14 0
Lolium italicum (*Italian Rye-grass*)	48	0 3¾	15 0
Poa trivialis (*Rough-stalked Meadow Grass*)	10	1 7	15 10
Poa nemoralis (*Wood Meadow Grass*)	14	1 9	24 6
Festuca duriuscula (*Hard Fescue*)	36	0 8½	25 6
Festuca ovina tenuifolia (*Fine-leaved Fescue*)	20	1 4	26 8
Dactylis glomerata (*Cocksfoot*)	30	0 11	27 6
Cynosurus cristatus (*Crested Dogstail*)	30	1 5	42 6
Alopecurus pratensis (*Meadow Foxtail*)	32	1 4	42 8
Festuca pratensis (*Meadow Fescue*)	56	0 9½	44 4
Avena flavescens (*Golden Oat Grass*)	18	3 0	54 0
Avena elatior (*Tall Oat Grass*)	56	1 0	56 0
Festuca elatior (*Tall Fescue*)	50	1 3½	64 7
Anthoxanthum odoratum (*Sweet Vernal*)	36	2 0	72 0

The above Table is intended to serve as a guide to the economical use of grass seeds. When making a selection of grasses, the following points should each receive due consideration:—

(1) Productiveness.

(2) Suitability of the species for the soil and climate, and for the purpose for which the seeds are required.

(3) Cost of the seeds.

From the Table of "Estimate of Productiveness," given on page 154, it will be seen that some grasses are capable of producing more than double the quantity of herbage that other species can produce, while from the above Table of the cost of seeds required to sow an acre, it will be observed that the difference in the cost of different seeds is very great. It must also be borne in mind that some of the species whose seeds are most expensive are inferior to others whose seeds are far cheaper. The price of seed depends on the cost of its production, and not on its real value or usefulness. Careful consideration of these matters is therefore necessary to a proper selection.

If the information given in these two Tables is conjointly considered it will not be difficult to select grasses that are at

once the most profitable and least expensive. Taking, for example, *Phleum pratense* (Timothy), which is the lowest priced seed in the above Table, it will be found on reference to the Table on page 154, that it ranks high as regards productiveness, so that this species readily takes its place as the cheapest grass seed, and therefore worthy of extensive use. On the other hand, *Anthoxanthum odoratum* (Sweet Vernal), the most expensive seed in the above Table, will be found to be one of the least productive (and at the same time a grass of inferior quality), so that it may be considered as unworthy of notice from an agricultural point of view.

More Seed should be Used when the Land is not in fine Tilth.

The capacity of even the small delicate-seeded grasses for establishing themselves under unfavourable conditions of soil, &c., is remarkable, and, in my opinion, sowing on rough land means chiefly a loss of a portion of the seed sown, but it does not prevent the remaining portion from ultimately doing well. My views are these:—If sown on a fine tilth, and under perfect conditions as regards moisture and heat, every seed having germinating capacity may be expected to germinate and establish itself, if not interfered with by birds or otherwise. If sown on soil not properly pulverized, a small and delicate grass seed falling on the outside of a clod might germinate, but might be scorched and killed by a day or two's hot sunshine and drought before it could obtain root-hold. If the same seed fell in a hollow, and was covered by a clod, it would have no chance of germinating, being too deeply covered. In both these cases the seeds are practically lost, and the outcome of the matter is that, while with a fine tilth and suitable conditions as regards moisture and warmth, a perfect germination from all the seeds sown may be immediately obtained, sowing on rough land cannot possibly give such good results, as probably one half of these fine seeds have fallen where they cannot succeed, and an extra allowance of seed should be sown on rough land to compensate for the seeds that will be lost.

Large-seeded grasses, such as cocksfoot, meadow and tall fescues, and ryegrasses, have naturally greater staying powers than the small-seeded grasses and the clovers.

It must be a question for the agriculturist to decide whether it will suit him best to prepare his land perfectly and sow less seed, or sow on rougher land and use more. It is often impossible to prepare land perfectly, and then there is nothing for it but to do the best one can in this respect, and not stint the seed when the land is rougher than it should be at the time of laying down.

Method of Mixing Permanent Grass and Clover Seeds to ensure their regular Distribution when Sown.

In order to secure the most perfect distribution of the seeds of all the species over the entire surface of the field, it is recommended that the Light Seeds should form one mixture, and be sown at one operation; and the Heavy Seeds should form a second mixture, to be sown at a second operation.

1st Mixture—Light Seeds.

Cocksfoot.	Rye-grass.	Chicory.
Foxtail.	Hard Fescue.	Burnet.
Meadow Fescue.	Tall Fescue.	Any other species.
Meadow Grasses (*Poas*)	Tall Oat Grass.	

2nd Mixture—Heavy Seeds.

Perennial Red Clover.	Late-flow. Red Clover.	Kidney Vetch.
Timothy Grass.	Alsike Clover.	Lucerne.
White Clover.	Yarrow.	Parsley.

To mix the seeds perfectly (a very important matter) they should be spread out in layers, one kind above another, on a clean floor, and then turned over with shovels several times until thoroughly mixed. It will be found most convenient to take each kind in the order stated above. Beginning then with Cocksfoot, spread this seed thinly and evenly on the floor (a wooden rake is most useful for spreading the seeds), then place the Foxtail thinly and evenly over the Cocksfoot, then similarly and successively the Meadow Fescue, Meadow Grasses, Rye-grass, Hard Fescue, Tall Fescue, &c. When all the seeds that are to form one mixture are thus laid down, proceed to throw the whole into a heap, and then, with the aid of wooden shovels, turn over the heap, from side to side of the room, three or four times, until the whole of the seeds have been thoroughly mixed. The mixture may then be put into bags ready for sowing. The second mixture should then be prepared in the same way.

APPENDIX II.

ON SOME NOTES ON THE SEED TRADE AND GRASS SEEDS SUPPLIED BY MR. JAMES HUNTER, AGRICULTURAL SEED MERCHANT, CHESTER.

When my late friend, Mr. Faunce de Laune of Sharsted Court, Kent, wrote, in 1882, his paper on "Laying Down Land to Permanent Pasture"*—a paper which initiated all the important results that followed it both in the seed trade and in the selection of seeds by agriculturists, as well as in the cleaning of seeds, which resulted in thistles and weeds being largely diminished—the grass seed trade in this country was in a most extraordinary condition, and illustrates the need, to which I have repeatedly called attention, for agricultural schools. For, at the time my friend wrote, Mr. James Hunter points out that "great ignorance of the permanent grasses prevailed both amongst seedsmen and agriculturists. Seedsmen knew little either of the species of grasses or their seeds, and agriculturists still less. When land was laid down to permanent grass a 'mixture' of seeds was ordered, and the agriculturist accepted whatever was supplied, as he had no knowledge to enable him to look after his own interests. Such being the case, adulterated seeds, and seeds of very inferior quality, were freely sold without any complaint being made by the purchasers; and, as the price of different grass seeds varies considerably, the cheaper kinds were used in excessive quantity. Thus, ryegrass, which is always low-priced, was largely used in permanent grass mixtures, and it was also the adulterant of meadow fescue, cocksfoot, &c. It might happen, therefore, that owing to the low quality and inferior germination of the grass seeds used, and the large proportion of ryegrass (usually of good germination) in the mixture, nine-tenths of the grasses in a pasture might be ryegrass. To Mr. Faunce de Laune is due the great credit of being the first to discover and draw attention to this great evil, and his efforts have had most beneficial results, not only in directing attention to the proper species to grow, but in creating a demand for pure seeds, which is now fairly supplied. It must not, however, be supposed that the sale of bad seeds has

* "Journal of the Royal Agricultural Society of England." Part I., No. XXXV. 1882. John Murray, London.

been stopped. A perusal of the annual reports of the consulting botanist to the Royal Agricultural Society of England will show that this is still too common. But with ordinary care on the part of the buyer, there is now no difficulty in procuring pure seeds." Mr. Hunter then gives the following extract from his price-list, which offers an easy and safe method of obtaining good seeds:—

"To enable purchasers to have their seeds analysed and tested before the time of sowing, any seeds required will be delivered carriage free to the purchaser, so that samples for analysis *may be taken from the bulks while they are in the possession of the buyer.* This method is more satisfactory than that of testing a sample received from the seed merchant before purchasing, as it excludes all doubt about the identity of the seed analysed. In the event of any kind of seed not fulfilling, in every particular, the guarantee of purity, genuineness, or per centage of germination stated in this catalogue, such seed may be refused, and returned at the expense of the seller, who will also in such a case pay the consulting botanist's fee."

With such a system at the command of the purchaser, it is now his own fault if he does not put down good seed.

Mr. Hunter deprecates the use of such a large quantity of clover seed as is commonly sown with grass seeds. He says that it has been customary to sow about 9 lbs. of clover, and a farmer in Scotland who has laid down much land to grass tells me that 12 lbs. to 14 lbs. are often sown. Mr. Hunter advises 5 lbs. of the best seed, and says that equally good results will be obtained as from sowing a larger quantity. I generally use 5 lbs. and find this ample; and, on showing a field of temporary grass sown with that quantity to a number of farmers, they could hardly believe that so little seed had been used.

As regards Sinclair's estimate of the number of seeds in a lb., Mr. Hunter observes that his figures cannot now be accepted, as better seeds are now available. "The number of seeds," writes Mr. Hunter, "in a lb. depends on the *quality* of the sample. Light undressed seed will give twice or three times the number of seeds to the lb. that perfectly-dressed heavy seed will do. To insure accuracy in this matter, I had all the seeds in my table carefully counted, using only samples of heaviest weight and purest quality, and my figures are now generally adopted."

APPENDIX III.

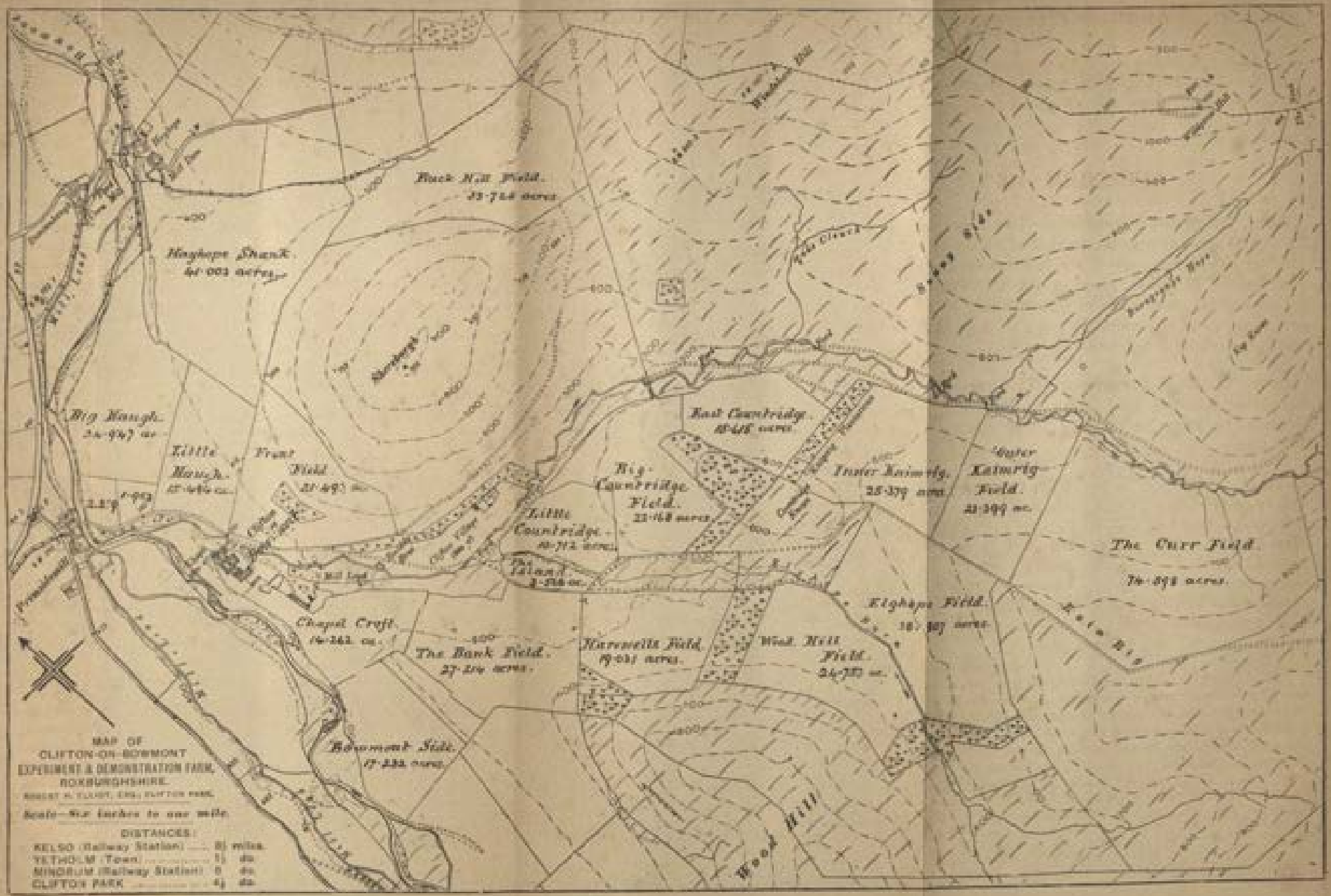
INNER KAIMRIG EXPERIMENT.—The Inner Kaimrig field of 25 acres of very poor soil at an elevation of about 750 feet has afforded one of the most useful and instructive lessons in grass growing on the Clifton Park System. Full particulars of the cropping of this field and its successful results are given on page 29 *et seq.*, to which the reader is referred.

OUTER KAIMRIG EXPERIMENT.—The experiment with the Outer Kaimrig field began in 1890, and the particulars are given on page 29. The mixture used in 1899 was—

	lbs.		lbs.
Cocksfoot	10	White Clover	2
Tall Fescue	5	Alsike Clover	2
Tall Oat-like Grass	5	Chicory	4
Hard Fescue	2	Burnet	8
Crested Dogstail	1	Kidney Vetch	3
Golden Oat Grass	1	Yarrow	1
Rough-stalked Meadow Grass	1	Sheep's Parsley	1
Late-flowering Red Clover	2	Field Parsnip	1

49 lbs. per acre.

Note.—It may be remarked here that there are several species of grasses and other deep rooting forage plants that are well suited for mixtures laid down on my system, but that are not generally used by me, and correspondents have asked me why I do not use them. The species I refer to are especially Meadow Foxtail, Meadow Fescue, and Timothy grasses, Lucerne, and Sainfoin. On soils that are suitable for them these are most valuable, but on light dry Cheviot hill land the three grasses named suffer from drought, while the Lucerne and Sainfoin, so valuable on the chalk soils of England, do not succeed with me.


Black Hill Field.
23·724 acres.
Haughpe Shank.
44·002 acres.
Big Haugh.
24·947 ac.
Little Haugh.
Front Field.
East Countridge.
Big Countridge Field.
Little Countridge.
The Island.
Inner Kaimrig.
Outer Kaimrig Field.
The Carr Field.
74·898 acres.
Chapel Croft.
The Bank Field.
27·214 acres.
Harewells Field.
West Hill Field.
Eighope Field.
Boarmont Field.
Wood Hill
MAP OF
CLIFTON-ON-BOWMONT
EXPERIMENT & DEMONSTRATION FARM,
ROXBURGHSHIRE.
Scale—Six inches to one mile.
DISTANCES:
KELSO (Railway Station) ..... 8½ miles.
YETHOLM (Town) ..... 1½ do.
MINDRUM (Railway Station) 6 do.
CLIFTON PARK ..... 4½ do.

The parsnip was put down as an experiment, but I have since formed the opinion that chicory is the more suitable plant, and is superior to the parsnip. The pasture—the seeds for which were sown May 8th, 1899, with oats, which proved a good crop—has given much satisfaction, and kept the following stock in 1900:—From April 27th to June 13th, 60 half-bred ewes and twin lambs; from June 13th to July 27th, 80 ewes and twin lambs; from July 30th to August 21st, 180 lambs; from August 21st to September 1st, 100 ewes; from October 5th to November 10th, 60 ewes. The ewes and twin lambs were increased from 60 to 80, as 60 ewes and their double lambs proved quite insufficient to keep the grass down. The field latterly could have kept much more stock, but has been lightly grazed towards the end of the season, as it is first year's grass. I regard this field as an interesting proof of what may be done with the vast areas of run-out and poor lands in these islands. The field is the most outlying one on the farm; it is extremely exposed, and has no plantation or hedge to protect it; its elevation is from about 700 feet at the foot of the field to 800 at the top. It had been taken out of the hill about seventy years ago, and worked on the five-course shift, and has never been manured since, with the exception of some artificials with the turnips, and the manure (a most important exception, I admit, if we consider all its effects) of a good turf grown with deep-rooting grasses and plants. Those who have not seen the field cannot believe in the amount of stock it has carried, but the explanation simply is that, if you grow a full supply of the most deep-rooting plants, you tap depths quite out of the reach of the shallow-rooting ryegrass, and certainly add about 30 per cent. to the available rootage area of the field; the large supply of plants of rapidly-productive powers does the rest.

BANK FIELD EXPERIMENT.—The Bank field consists of 27 acres, rather more than half of which is poor, stony, and exposed, and in some parts very steep land. The remainder consists of fair medium soil for that part of the country. For the last nineteen years 24 acres of the field have never been manured, excepting with the artificials used with the turnips. The remaining 3 acres have once—some years ago—had some farmyard manure, and the seed mixture used in 1900 was :—

	lbs.		lbs.
Cocksfoot	14	White Clover	2
Tall Fescue	7	Alsike Clover	1
Tall Oat-like Grass	7	Yarrow	1
Rough-stalked Meadow Grass	1	Burnet	8
Late-flowering Red Clover	2	Kidney Vetch	3
		Chicory	3

Total, 49 lbs. per acre.

This mixture,* I think, is an improvement on former mixtures, as, at about the same cost, there is supplied a larger quantity of the most hardy, drought-resisting, early, and productive grasses. It is a safe mixture, because the seeds of the large grasses are much less liable to fail than those of the smaller ones, and it is calculated to leave a greater quantity of vegetable matter for the

* As an alternative mixture to that sown on the Bank field in 1900, I approve of the following mixture suggested by Mr. Hunter, as suitable for laying down good soils at a moderate elevation on my system, and I have myself used it successfully on such soil on another part of this estate. This mixture contains, in addition to the kinds used in the Bank field, Meadow Fescue, Meadow Foxtail, and Timothy grasses, all valuable on good low-lying moist and rich soils :—

	lbs.		lbs.
Cocksfoot	8	Late-flowering Red Clover	2
Tall Fescue	4	White Clover	2
Meadow Fescue	6	Alsike Clover	1
Meadow Foxtail	4	Yarrow	1
Tall Oat-like Grass	4	Burnet	8
Timothy	3	Kidney Vetch	3
Rough-stalked Meadow Grass	1	Chicory	3

Total, 50 lbs. per acre.

succeeding crops. Later observation of the suitability of the golden oat grass to this description of soil has suggested the addition of ½ lb. or 1 lb. per acre. After the first ploughing of the grass and our usual rotation of cereal and turnip crops, it has been found that the fineness of the tilth then permits the use of a smaller quantity of seeds than used in 1900 for the Bank field; consequently, the Inner Kaimrig and Harewells fields were laid down in 1903 with only 10 lbs. cocksfoot, 5 lbs. tall fescue, and 5 lbs. tall oat grass, together with the other seeds used in the Bank field mixture, and thus far the results are entirely satisfactory. Farmers, I observe, have a prejudice against grasses which, like cocksfoot and tall fescue, may become coarse, but such grasses are either fine or coarse, as the farmer is intelligent or uninformed. The intelligent farmer sows plenty of the seeds, and grazes the grasses so that they may be kept in a constant succession of young leaves; the uninformed farmer puts down a small quantity of the seeds, with the result that each plant grows like a bulrush, whereas by crowding the plants each one becomes small and fine. We have a pasture of about four acres at the head of Bowmontside field, which was laid down in 1887 with the intention of its being taken up again with the rest of the field, but it was fenced off and left in permanent pasture, as the land was so steep. The mixture consisted of—

	lbs.		lbs.
Cocksfoot - - -	16	Perennial Red Clover -	2
Perennial Ryegrass - -	4	White Clover - -	4
Hard Fescue - - -	2	Alsike - - -	3

This pasture has done well, and always remained fine, and even when let up to a considerable extent, so that part of the pasture was a mass of cocksfoot heads, the grass and flowering stems were not coarse.

Returning to the Bank field experiment. As our previous hay crops had been very heavy—sometimes

about 3 tons an acre—I adopted the following treatment in order to lessen the hay crop, and so favour the subsequent pasture. After harvest, and rolling the field, it was stocked for five weeks with 4 hoggs an acre and 11 calves for the entire field, and from the first week in April to May 20th with never less than 2 ewes and twin lambs per acre, and often 3 ewes and twins. The field was then shut up for hay, which is estimated at about 2 tons an acre, and would have been certainly much more had it not been for a drought so severe that sheep absolutely refused to go up to the top of one of our hills, while the tails of the peacocks have fallen out far earlier than usual. In the hay there is very little chicory, and hardly any seeding stems, and, as the chicory is composed almost entirely of young leaves, it is thought that it will not cause the hay to be dusty, which is the great evil arising from fully developed chicory when used for hay. The produce from the coarse grasses is as fine as could possibly be desired. In the judgment of a visitor, whose opinion is to be valued, it would be impossible to produce a finer sample of hay. With the exception of about 3 acres, only once manured with dung about six years ago, the field has never been manured since 1887, in the ordinary sense of the word; and yet, from the colour and luxuriance of the clover and kidney vetch, the agriculturists who saw the field thought it had been dressed with nitrates—and so it had been most fully from the atmosphere. The fact is that with our system no manure is required over and above that supplied by a deeply-rooted turf, the nitrogen collected from the atmosphere by our abundant clover and kidney vetch, and the artificials used with the turnip crops; and this has now been amply proved by stock and crops all along the line. In the case of last year's (1901) drought, when there was such a general failure of grass, and especially of clover, the Bank field had a most luxuriant appearance all the season through, and the results clearly prove that, with the aid of the new farming system, the farmer may

regard the worst drought with absolute indifference. From October 1st, 1900, to October 1st, 1901, the value of grazing and hay obtained was estimated by us at £7 3s. an acre. Our estimate has been referred to a tenant-farmer, who is employed as a valuator, and his estimate comes to rather more—£7 7s. 6d. an acre.

From October 2nd, 1901, to October 1st, 1902, the field has been stocked as appended, and I purposely allowed it to be so much later in the autumn and winter than was judicious in order to see how the new mixture would stand the roughest treatment; and the effect of this, as might have been anticipated, has been a decline of the clover, though this seems to be recovering, and there is now an abundant feed of grass in the field, which is still stocked with 60 ewes. The list of the stock is as follows:—

From October 1, 1901, to December 31, 1901, 4 ewes per acre, with the assistance of one cartload of either cabbages or turnips per day for the field.

From March 15 to May 24, 1902, 3 ewes and single lambs per acre, with the assistance of two cartloads of turnips per day for the field.

From May 24 to July 28, 1902, 2½ ewes and single lambs per acre.

From July 28 to October 1, 1902, 3 ewes per acre.

From May 1, 1902, to June 10, 5 cattle.

From June 13 to September 4, 2 horses.

This field, sown in 1900, according to my 8-course rotation system, ought to have been ploughed up three years ago, but has been retained in grass partly because it has grazed so well, partly because visitors asked to see the Bank field, partly because it was the first mixture of the kind ever used, and partly because I wished to see by analysis (*vide* Dr. Voelcker's reports, Appendix IV.) whether the fertility of the soil was increasing or diminishing. Its grazing value is still (1907) so great that it has been decided to leave it in grass for another year.

EXPERIMENTS IN ALGHOPE FIELD.—This field was laid down with a crop of barley in 1884 by the new tenant, the mixture consisting of ryegrass and clover, with a very small quantity of cocksfoot. In 1896, or twelve years later, about 16 acres of the central portion of the field was ploughed, and the turf laid over as flat as possible. In 1897 it was sown with rape, which was eaten off by sheep. In 1898 it was sown with oats (which proved to be a fair crop), and

	lbs.		lbs.
Cocksfoot - - -	14	Yarrow - - -	1
Tall Oat Grass - -	4	Sheep's Parsley - -	1
Hard Fescue - - -	2	White Clover - -	2
Crested Dogstail - -	1	Late-flowering Red Clover	2
Burnet - - -	8	Alsike Clover - -	1
Chicory - - -	3		

Total, 39 lbs. per acre.

After the first ploughing the reversed turf was not stirred, but the ground merely harrowed. In 1899, in consequence of the fence having been taken down between the experimental portion and the northern portion of the field, which had been laid down to grass after a course of cropping, the stock neglected the former, and hence the wild grasses in the reversed turf got too much ahead, and injured the newly-sown grasses; and this, of course, interfered with the experiment. In 1900, however, the newly-sown grasses showed much better, and the stock distributed itself evenly over both portions of the field, and the experimental portion has much improved. In 1901 the field is to be entirely grazed with cattle till the autumn, or until the grasses have shed their seeds. So far as we can see, the field seems to show that by simply reversing the turf of an old pasture it may be cheaply laid down with superior grasses at a very moderate expense, as, after ploughing once, nothing further is required except harrowing and rolling. It is, of course, essential that tall strong grasses like cocksfoot, tall fescue, and tall oat grass should be

freely used, as these will overcome the grasses and weeds existing in old pasture to a very great extent, if not entirely, though the latter is a point that remains to be proved. I omitted tall fescue in this experiment in order to lessen the cost of seed.

It was very noticeable how superior the end rig of the experiment was to the rest of the field, and this evidently arose from more seed having fallen there (from the sowing machine slowing). This confirms, of course, what is well known, that the rougher the ground the more is the seed required. It yet remains to be proved whether, in such cases, it will pay better to put down more seed, or rely on the difference being made up by allowing the grasses to seed. I regard this experiment as one of great importance, as, for various reasons, it would often pay better to reverse the sod, and lay down after a crop of rape, than to put the land through a course of cropping. The above alluded to central portion of Alghope field has turned out to be as satisfactory as could be expected, taking into consideration that the lifting of the fence injured the experiment. In 1902 I dug up some turfs of it (then four years old) in order to compare them with turfs taken from the section laid down in 1884, and found much more rootage in the former, and that the turf was thicker. Altogether, the pasture was much improved by the operation, and is now free from moss, while the pasture of 1884 is thick with it, and in a most unsatisfactory condition in consequence. In the south-west corner of the 1884 section I have experimented this year (1904) by reversing the turf, harrowing it, sowing grass and clover seeds with rape on one portion, and grass and clover seeds with buckwheat on the other. So far as I can see at present, the buckwheat will be much more favourable to the grass than the rape, as the former disintegrates the surface soil thoroughly, and so leaves it in a much more open condition than is the case on the rape section, the surface soil of which is quite hard. Next year, on the

1884 section, I am going to experiment by ploughing up the turf thinly, turning it back again, and sowing cocksfoot, clover, chicory, burnet, and kidney vetch, and some golden oatgrass over the interstices. This, I think, will be successful, and, should it be so, the idea will be of great value to those who have poor mossy pastures which they wish to improve at small expense. I am in hopes that it will succeed, from observing the immense improvement that took place in the mossy slopes of the terraces at Clifton Park, when the turf was lifted and replaced after levelling the inequalities in the slopes. No grass seeds were sown, nor manures applied, and yet there was an immediate and great improvement in the slopes, and the moss quite disappeared.

(Later Note on the foregoing experiments: Partly from the immense growth of Holcus lanatus that sprang up, and partly from the defects of the season, neither of these experiments were encouraging; but there can be no doubt that a certain proportion of the newly-sown mixtures was introduced, and until the plots have been grazed, which they will be in October, 1907, it will be impossible to speak decidedly on the subject.)

DIFFERENCE BETWEEN FIVE-COURSE ROTATION AND THAT ON MY FARM.—Our rotation is as follows:—Turnips out of grass, oats, turnips, and either oats or barley with grass seeds, when the land is left for four or five years in grass, fields being taken up again a year earlier or later as may appear advisable from the condition of the grass. If we take three rotations of eight years each, which is practically my system, there will be twelve years of grass, six of turnips, and six of corn. Taking five rotations on the five-course system, there would be ten years of grass, ten of corn, and five of turnips. The great change in the system is that by altering the old system from grass crops in divisions of two years each to the new one of putting them into periods of four years each, I am enabled, at no greater average cost per annum, and even at less, to put down a first class grass mixture which will not only yield much more and certain food, but leave behind it for the succeeding crops a rich and deeply-rooted turf.

EXPERIMENTS OF THE CAMBRIDGE UNIVERSITY DEPARTMENT OF AGRICULTURE

at Abbotsley, with

PERMANENT PASTURE ON POOR CLAY SOIL.

At the meetings of the Royal Agricultural Society of England, held at Park Royal, London, in 1903, 1904, and 1905, the Cambridge University Department of Agriculture exhibited turfs from their experimental pastures at Abbotsley, Hunts, and the Department made the following reports :—

JUNE, 1903.

"Four turfs from Abbotsley, Huntingdonshire, showing pastures produced on stiff clay soil by various 'seeds' mixtures. The seeds were sown about June 1st, 1900, and 10 cwt. basic slag per acre was applied in the following autumn.

"Details of the seeds mixtures will be found in the Fourth Annual Report of the Department. The turfs exhibited are (*a*) from Plot I., a mixture of perennial ryegrass and clovers—47 lb. seeds, costing 14s. 6d. per acre, moderately satisfactory; (*b*) from Plot V., a mixture of permanent grasses and clovers—38 lb. seeds, costing 45s. 9d., moderately satisfactory; (*c*) from Plot VII., same as Plot V., but sainfoin in place of clovers—50 lb. seeds, costing 46s., not satisfactory; (*d*) Plot VIII., sown with Elliot's 1895 mixture *—45½ lb. seeds, costing 39s. 6d., most satisfactory. On the poor clay soil of Abbotsley eight different mixtures have been tried, and at the present time Elliot's is much the most promising. The soil is now evenly covered with herbage, which looks as if it would be permanent. None of the other mixtures have, so far, produced a close turf."

* The Inner Kaimrig Mixture of 1895. *Vide* p. 31.

JUNE, 1904.

"Set of seven turfs from Abbotsley, Hunts, showing the pastures produced in the fourth season by various mixtures of seeds sown in 1900, viz. :—1, mixture of ryegrass and clovers, costing 14s. 6d. per acre; 2, mixture of perennial ryegrass and the chief pasture grasses and clovers, costing 28s. per acre; 3, a mixture of the chief pasture grasses and clovers, without perennial ryegrass, costing 30s. 6d. per acre; 4, one of Elliot's special mixtures*, costing 39s. 6d. per acre. All the above manured with 10 cwt. basic slag per acre in autumn 1900. No. 4 represents much the best of the pastures."

No. 4 mixture was that used by Mr. Elliot in 1895 for laying down 25 acres poor land, and now in the fourth season. The turf from this mixture now exhibited is labelled as follows :—

"Much the best of the pastures, a close even sward, closely grazed by stock."

JUNE, 1905.

In June, 1905, the Cambridge University (Department of Agriculture) again exhibited a series of turves from their Experimental Pastures at Abbotsley, then in their fifth year; and the turf from Mr. Elliot's 1895 mixture * was thus described by the Department :—

"*The best of the pastures; surface evenly covered; herbage much liked by stock, and always closely grazed.*"

"In placing the Abbotsley plots in order of merit, we may say, 'No. VIII. (Mr. R. H. Elliot's 1895 Mixture *) first, the others nowhere' "—Professor Middleton on the "Formation of Permanent Pastures," in the Journal of the Board of Agriculture for November, 1905.

* The Inner Kaimrig Mixture of 1895. *Vide* p. 31.

NOTE.—It will be observed that the Inner Kaimrig Mixture of 1895, designed for poor light Cheviot-hill land, has proved the best of all the mixtures sown on the poor stiff clay soil at Abbotsley, Hunts., thus shewing the adaptability of the Clifton Park Mixtures to all classes of soils.

SUCCESS OF THE CLIFTON PARK SYSTEM IN GROWING POTATOES WITHOUT MANURE.—I now pass to an experiment with potatoes in the case of the Haugh field of 27 acres—a shingly-spotted haugh on the banks of the Bowmont—which, in our early experience of the farm, always suffered extremely from drought. It was laid down in 1893 with one of my mixtures containing chicory, burnet, &c., and was ploughed up at the close of the year (1900), and partly sown in 1901 with potatoes, and partly with turnips. The former, which were manured with dung and kainit, at an estimated cost of £2 10s. an acre, gave 15 tons per acre. Those which had no manure gave 14 tons 6 cwt. Estimating the potatoes at £2 per ton, the result was £1 2s. in favour of the unmanured portion. In the case of the Balderston farm potato experiments near Linlithgow in 1903, no less than 20 tons of dung per acre and 7½ cwt. of "artificials" per acre were used. The Up-to-Date variety gave 10 tons 18 cwt. 6 lb. The same variety at Clifton-on-Bowmont gave 13 tons 14 cwt., and there were practically no diseased potatoes, only an occasional one such as, I am told, is commonly seen in nearly all cases, whereas there were 7 cwt. 2 lb. of diseased potatoes in the case of the Balderston experiments with the Up-to-Date variety. The Evergood variety gave less in quantity than we obtained from the Up-to-Date variety, and was free from disease, so that had I been allowed to compete I should have come out at the top with the aid of a variety which stands fifth on the list, and shown a much larger profit, as I used neither dung nor artificials. See also page 121.

TURNIPS GROWN WITHOUT MANURE.—In the Big Haugh field some drills of turnips were sown without any manure in 1901 and 1903, and answered so well that in 1904 I ventured on sowing a whole field (the East Countridge) with them. The result has been most satisfactory, and competent judges have declared that it would be impossible to have a finer crop of turnips. But though the crop and the quality of the turnips were both good, I do not advise farmers who may adopt my system of farming to run the risk that would be incurred by omitting the usual application of artificial manures, for though they may be dispensed with in favourable seasons the stimulus required in unfavourable seasons could not be wisely dispensed with.

CAUSES OF YOUNG PASTURES FAILING.—When they do, it is commonly attributed to want of sufficient food for the plants. I believe it is more often owing to defective soil conditions, Dr. Voelcker, chemist of the Royal Agricultural Society of England, tells me that he has often been consulted on the point, and on analysing the soil found that there was plenty of plant food in the land if the roots could only have freely travelled through the soil. I have the following reason for believing that the hard pan which sometimes exists just below the ploughing depth is often the cause of failure, partly because the roots of grasses and clovers cannot penetrate it, and partly because it checks the rise of water from the subsoil. The Longshot field—Crookhouse farm (*vide* page 83)—is a case in point. When previously in ordinary arable cultivation, during about 45 years, it never would grow grass. I laid it down twice to permanent pasture, and in the second case with an excellent mixture, but which did not contain any of the deep-rooting plants I now use. In both cases the pasture was a failure. In 1895 I again laid it down to permanent pasture. The field, now five years old, has been throughout a complete success. This I attribute to the deep-rooting plants used, and especially the chicory, which was a very large crop, and which, as described at page 83, went straight down into the subsoil, after penetrating the very hard pan which lay below the ploughing depth. From the facts connected with this field previous to my occupation of it, and which I have personally ascertained from the former tenant, I have reason to surmise that the failure of land to grow grass and clover well, either when in rotation husbandry or being laid down to permanent pasture, must often be owing to hard pans below the ploughing depth, and this, of course, makes it the more advisable that plants like chicory and burnet, which can penetrate the hardest pans (*vide* page 83), should be freely used. But besides the evils arising from hard pans, there is the fact that our soils are not kept sufficiently open owing to the deficiency of humus in the land, and hence the roots cannot readily traverse the soil, which, as Dr. Voelcker has shown, often contains enough plant food if it were fully available for the use of the plant. If, then, you do not give the plant a soil well opened up, and kept open by humus, you must spend more money in manure. In other words, as far as the plant is concerned, a small quantity

of manure in an open soil is of more practical value than a much larger quantity of manure in a soil of inferior physical condition. There are three losses entailed by inferior physical conditions of soil—(1) That the plant is less able to contend with adverse seasons; (2) that the expense of manurial application must be greater; and that (3) much of the manure that is applied in excess of the requirements of the plants will be lost by waste or downward percolation, while much of it is liable to enter into insoluble compounds in the soil.

MIXTURE OF DROUGHT-RESISTING PLANTS FOR BARE ROCKY SURFACES.—Arthur Young, in his "Elements and Practice of Agriculture," has recommended for chalk soil a mixture of yarrow, burnet, trefoil, white clover, and chicory, so that the pasture would be formed of plants not one of which is a grass plant. On full consideration, I think it probable that Arthur Young is quite right in limiting his selection for thin lands to plants that he was sure would flourish on them, and as there are often, on hill lands especially, gravelly slopes of thin soil, on which grasses at once dry up in a drought, I have corresponded with Mr. James Hunter as to the proportions for a mixture composed entirely of drought-resisting plants other than grass, and he has sent me the following mixture, to which, however, he has added one grass. The mixture is as follows:—

	lbs.		lbs.
White Clover	4	Chicory	4
Kidney Vetch	6	Ribgrass	4
Yarrow	1	Crested Dogstail	3
Burnet	8	Total, 30 lbs. per acre.	

Such a mixture might be sown on the steep, gravelly banks of a field, and the remainder of the land sown with whatever mixture was most suitable. Two acres of the Shereburgh field, where the soil is shallowly distributed over a rocky surface, were sown in 1900 with this mixture, and in 1904 the results shown were most satisfactory, and a fair amount of grazing has been attained, where almost nothing could have been expected from an ordinary grass mixture. This year (1907) shows a continued satisfactory result, so much so that I can confidently recommend that a trial should be made of this mixture for poor, shallow, heads of fields, on which a good mixture would be thrown away.

IMPORTANCE OF DROUGHT-RESISTING PLANTS.—The severe droughts of 1898-99 proved the great value of the mixtures used, as in the former year we had about three and in the latter two tons of hay an acre. In 1899 the results were most remarkable, as the land was exposed, light, and shallow. We were indebted for the bulk of the crop to the kidney vetch and clover (the late-flowering red clover used stands drought in a wonderful way), and especially to the former. The field (*vide* remarks on kidney vetch, page 107), was a veritable oasis surrounded by a girdle of scorched hills, and with any mixture ordinarily used the crop must have been a disastrous failure.

HOW MOST CHEAPLY TO RE-SEED PASTURES. — Superior grasses are liable to decline in pastures, because the culms are eaten by stock, while grasses, inferior in quality or productive power, like Holcus lanatus, bent grasses, and crested dogstail (the last, though a good grass, is a small producer, and it is not desirable to have a large quantity of it) tend unduly to increase. Mr. Faunce de Laune sought to overcome this by turning out stock at the time when the flowering culms were growing, and re-stocking after they had seeded; but this course would often not suit the circumstances of the farmer, and I think it would be better to hurdle off a strip on the side of the field on which the strongest winds blow, and then remove the hurdles after the seed had fallen or been blown across the field. I am led to suggest this from having observed how cocksfoot spread in the southerly portion of the Alghope field from a strip cut off for planting. I have noticed the same effect in the Glebe field. In the Cottage Park large grasses have appeared from cows and horses being fed on hay of tall grasses, and the land having been dunged. In cases where the winds are not strong, it would probably answer better to enclose a strip of about an acre in the middle of the field, and then shift the hurdles each year. By this process the whole field could be cheaply re-seeded, and, as I have elsewhere shown, letting up the grass would destroy the moss, which commonly exists to a greater or less degree in nearly all old pastures, and would heavily re-seed the enclosed portion, as letting up the grass opens the ground and favours the germination of the seed.

THE GRAZING OF PASTURES.—Dr. Shirra Gibb says: "I have obtained excellent results from what I term "rotation grazing"—alternating breeding sheep, feeding sheep and cattle—either yearly, or in some cases quarterly. I consider this much better than mixed grazing so often practised."

AFTERMATH MUST BE LIGHTLY GRAZED.—The Inner Kaimrig (sown in 1895) gave 2 two tons of hay an acre, which is a heavy crop, considering that it is the poorest field on the farm, and grazed well till it was ploughed up at the end of 1899. Bowmontside field, sown in 1897, gave in 1898 about 3 tons an acre of hay. It is one of the best fields of the farm, and yet it has grazed badly, though it was top-dressed with dung in the autumn of 1899; while the Inner Kaimrig had no manure, and the grasses in the Bowmontside field still remain poor and weak, though the pasture has quite closed up at the bottom. Though the season of 1898 was one of drought, and thus unfavourable to the Bowmontside field, much of the unfavourable result is, in my opinion, to be accounted for by the fact that the aftermath was closely eaten; while I took pains to see that, in the case of the Inner Kaimrig, it was lightly grazed, as the land was of such poor quality. In grazing, then, the poorest field on the farm, though unaided by manure, has beaten one of the best, though it was aided by manure. This experience supports that of Mr. Knight (*vide* page 54).

EFFECTS OF HAYING LAND FIRST YEAR.—All our experience proves that if the land is heavily cropped with hay the first year to the extent of from two to three tons an acre, farmyard manure should be applied before winter sets in. If that is not available, apply superphosphate and kainit, but no nitrates, as these encourage the grasses at the expense of the clovers. I have since come to the conclusion that even if farmyard manure is available, it is not advisable, for the sake of the pasture, to have a crop of more than 2 tons of hay in good and 1½ in the case of light land, and that the crop should be diminished by light grazing in the spring.

IMPORTANCE OF ROLLING LAND WHEN LAYING DOWN TO GRASS.—Grass seeds often fail from the want of moisture close to the surface. This want can be diminished by fine tilth and heavy rolling. Both tend to raise water from below by capillary (from *capilla*, a hair) attraction. This is explained by the fact that if you immerse a tube of very small bore, and open at both ends, in a vessel of water the water within the tube will rise to a sensible height above the surface of the water in the vessel, and the smaller the tube the higher will the water within it rise. On this well-established principle depends the rising of water through the interstices of the soil, and the smaller these are made by fine tilth, and the compression of the land by rolling, the more freely will water rise to the surface. Per contra, there is hardly any capillary attraction through dust, as the spaces between the particles are too wide, and hence a mulch of dust keeps moisture in the soil—in other words, the moisture being kept further from the surface cannot readily evaporate. A fine surface soil, then, when in a loose state, conserves water by preventing it rising to the surface; while you have only to roll it if you wish to bring moisture to the surface to aid in the germination of the seed and the support of the young plants which, from lack of moisture, are apt to be starved to death. It is important to note that rolling in warm weather makes land warmer, and in cold weather colder (*Vide* Fletcher, "Soils," page 176).

EFFECTS OF THE SYSTEM IN PREVENTING LOSS FROM WASH.—On August 23rd, 1900, a most severe thunderstorm raged along the Cheviots, inflicting great damage, and especially in the case of turnip fields, where soil and turnips together were in some cases washed right off the land. In the case of the three turnip fields at Clifton-on-Bowmont, one of which received the water from a steep hard hill above, there was no loss. In the latter case no muddy water left the field. It was all absorbed in consequence of the decaying turf, and decaying roots of the deeply-rooting plants, which acted as channels to let the water quickly down into the land, and it rose in the shape of clear water at the foot of the field, running out under the gate for several days. The Harewells field in 1903—a very wet year—showed the same results as regards the absence of wash.

MOSS.—IMPORTANT RESULT IN OUTER KAIMRIG.—This field was laid down to grass in 1890, but with only a most trifling amount of deep-rooters—1 lb. of chicory, 3 lbs. of burnet, and 1 lb. of kidney vetch. Four years afterwards it showed so much moss that I ordered it to be ploughed up. It was re-laid again in 1899—in 1903, and next year, 1904, (when the field was ploughed up) there was no moss. I attribute this happy change partly to a large supply of deep-rooters being used, and partly to the vegetable matter from the ploughed-up turf.

MOSS.—LETTING UP FOGGED-UP, OR MOSSED-UP, HILL PASTURES.—It has been previously pointed out that letting-up pastures destroys the moss, and it would be important to experiment as to how far it would pay to let up portions of hill pasture by keeping stock off till the autumn, or by hurdling off a section of a pasture each year.

Dr. Horne, in "The Principles of Agriculture and Vegetation," Edinburgh, 1757, p. 159, mentions a method for destroying moss, and recommends that a pasture should be shut up from May 15th to the beginning of December, and then grazed from that time to April, after which the field is to be shut up for hay. "The fog," he says, "being so long covered by two successive crops of grass, is cut off from the benefit of the air, and so dies."

SAFETY OF THE SYSTEM AS REGARDS HAY AND PASTURE.—One of the most experienced farmers on Bowmont Water once told me that he estimated that they suffered from drought one season out of three. Since taking up the Clifton-on-Bowmont farm, in 1887, our hay crops have always been good, though we have had some seasons of severe drought, besides other minor droughts. In one of these, with the old system, much of the stock would have had to be sent off the farm; the flocks in the neighbourhood greatly suffered, while we had abundant feed, in consequence of the drought-resisting nature of the mixtures used, and it may be mentioned that the stock kept considerably exceeded that formerly kept on the farm previous to my occupation of it.

Effects of the System in Abolishing Weeds.—By taking turnips after grass instead of oats, the cereal crop with which farmers begin their cropping rotation, you spring any weed seeds there are in the field, whereas in the case of taking oats after grass the tendency is to plough down, and so conserve both weeds and their seeds. As we take a second turnip crop before laying down, this, of course, still further cleans the land, so that weeds are abolished by the time we lay down to grass. We then so fully fill the field with grass plants, and fill up every vacancy by re-seeding if necessary, that there are practically no weeds in the pasture, a fact to which my attention has been called by more than one visitor.

Comparison of the Results of the New System at Clifton-on-Bowmont with those of an adjacent Farm.—I have found that the Inner Kaimrig field of 25 acres has kept as much sheep stock as the 87 acres of the fields of an adjacent farm, where the soil and situation throughout is certainly better than that of my field, which is by far the poorest on the farm, or certainly was so till well supplied with humus from the ploughed-down turf. The adjacent farm is kept on the old five-course system, and the mixtures used are clover and ryegrass. But this is far from being all. When my neighbour puts down turnips he will have to manure them with dung or artificials, and will probably do so with both; while the fine turnip crop grown in the adjacent field (East Countridge) to the Inner Kaimrig, without any manure, proves that my land requires neither.

Grass Inoculation, or Laying Down Land to Permanent Pasture by Transplanted Turf.—I began to experiment as regards this many years ago, but did not continue to do so, as I came to the conclusion that all our old pastures were too full of weeds and inferior grasses to justify inoculation from them, and now that a perfectly clean pasture, undistinguishable from old grass, can be created under my system of farming in four or five years, by using the proper seeds, there seems to be no justification for resorting to the expensive and troublesome method of forming a pasture by inoculation.

SUCCESS OF THE SYSTEM AS REGARDS CROPS, STOCK, AND CULTIVATION.—Lord Leicester (*vide* page 18) found that he could produce better crops on poor land without manure than he could produce on good land under the old four-course system, if only he laid the former down to grass for a period of not less than six years, and, after ploughing up, began his rotation with turnips. This gave time for the turf to rot, and then he was sure of a good crop of corn the following year. My experience is the same as Lord Leicester's, but, as I have explained (page 20), I feel sure that, with the mixtures I suggest, a much better turf can be produced in four years than could be produced in six years with the mixture used by Lord Leicester. The period he requires—a minimum of six years—is, if my mixture with deep-rooting plants be used, longer than is necessary, and, so far as our experiences go, would not be as suitable for a tenant-farmer. I need hardly say that all views on this point must be formed in accordance with the circumstances of each particular locality—*i.e.*, a longer period under grass may suit some districts, and a shorter one other localities.

EFFECT OF SYSTEM AFTER PLOUGHING THE SECOND TURF.—Though the advantages of the system are at once apparent, it is not till the second turf is ploughed up that the immense effect of plant roots as tillers of the soil is fully apparent. The first turf does much, of course, in the way of ameliorating the soil and adding to its bulk; but the ease with which the second turf is ploughed up, and worked for turnips, shows a complete amelioration of the physical condition of the land, the cause of which is at once apparent when, on closer inspection, you find it to be interpenetrated with rootlets and vegetable matter in various stages of decay. It is now a good nest for plants, and the results of this are apparent all along the line, on the turnips, oats, grass, and the hay crops, while a great improvement takes place in the health of the stock—partly from the plants used (some of which, like burnet and yarrow, have a proved good effect on the health of sheep), partly from the variety of food existing in the pasture, and partly from the land being in a more healthy condition, as a deeply-aerated soil, well supplied with humus, at once dries up quickly after rain, and yet maintains itself in a sufficiently moist condition from the moisture-retain-

ing power of vegetable matter. The results of the whole surroundings have had a remarkable effect on the sheep at Clifton-on-Bowmont, and not only has their health, condition, and quality improved, but the death-rate, which, in the case of flocks kept partly on hill lands and partly in fields, on large farms, is about 5 per cent., has fallen to about 3 per cent. The healthy conditions have told most markedly on the turnips, which are quite free from disease, though the season has been most favourable to the appearance of this serious evil—one of the worst that the farmer has to contend with.

Filling up Vacant Spots in First Year's Grass.—I have previously called attention to this (page 68). Sinclair points out (page 243, 2nd edition, Hortus Gramineus Woburnensis) that even in a field where blanks are not very noticeable, owing to the leaves of the plants covering the ground, they will amount to from 10 to 15 per cent. of the area. It is important to remember that, if a field is not fully shaded with grass, vacant spots—small though they may be—much increase the loss of moisture from the field, especially in the case of drying winds. Young grass plants more often suffer from want of moisture than from want of manure. It is important always to use a rake to cover the seeds. I once found that in the case of a tilly ridge there was a considerable number of vacant spots, which I was at a loss to account for, till the steward told me that he had not used a rake, but merely scattered the seed on the ground, because in the case of other fields he had found that the re-seeding had succeeded without any raking. In certain soils it would, no doubt, but even then the use of the rake is advisable, as the seeds can be covered with soil, when they would be less visible to birds and mice. It is of the utmost importance to fill the field with grass plants because (1) more stock can be kept, (2) weeds can be excluded more effectually, and (3) every part of the soil will be at once permeated, and so kept open by rootlets. Farmers have in some cases refused to credit the account of the stock we have kept per acre; but if they will fill up their land with plants which produce abundantly, and are of rapidly-reproductive, drought-resisting, and deeply-rooted character, they could keep one-third more stock, and keep it in much better health and condition, and be sure, too, of better crops when the land is again ploughed up.

SUCCESS OF THE SYSTEM AS REGARDS TURNIP DISEASE.—While I never remember to have heard such numerous complaints as regards this in the district there is not a sign of it at Clifton-on-Bowmont, and our turnips (about 70 acres in three fields in different parts of the farm) have looked most healthy throughout, and one of the fields has not been limed within the last forty years. While not denying that this disease may be propagated, even when good soil conditions exist, I am satisfied that, as in the case of man and animals, healthy surroundings will keep off disease, or reduce it to a minimum, even when the season is most favourable to its appearance. In the case of the Clifton-on-Bowmont fields there was an ample supply of vegetable matter from ploughed-down turf, and the whole soil was thus admirably calculated to withstand vicissitudes of weather. And that favourable soil conditions are of the utmost importance as regards the diseases to which turnips are liable, we have excellent confirmation in the case of the Crow Wood field, on the Linton farm, which was once in my hands. This I found, on a careful analysis, had less than ½ per cent. of lime in the first nine inches of the soil, and it has not been limed within about the last fifty years. I was urged to lime the field, but refused to do so, as I could hear of no turnip disease. The farm was let about thirteen years ago, and the tenant informs me that on the part of the field which consists of a fine sandy loam there is practically no disease—perhaps a turnip here or there; while on another part of the field, where the soil was of a different character, the disease had in former years made its appearance, but was checked by an application of lime. But, as we have seen, the disease practically has been non-existent on the sandy portion of the field, though it contained so little lime that agricultural chemists tell us that crops, under such low lime conditions, cannot be profitably grown. Good physical conditions, then, whether in the case of a soil well permeated with vegetable matter, or in the case of a sandy loam of equally good conditions, being favourable to the health of the plant, seem equally unfavourable to turnip disease. Large sums are spent in heavily liming land for no other reason than because it is a preventive of turnip disease. But from my long experience on this estate I am strongly of opinion that all the money spent on remedies or preventives might be

saved were the land well stored with turf in various stages of decay. My experience in the case of my Indian coffee plantations strongly confirms this view. As long as our soils were stored with the vegetable matter of the primeval forest all diseases to which our coffee was liable only existed to a trivial extent, but as the land became exhausted of its vegetable matter, and our soils thus lost physical condition, such diseases much increased. They can, however, be again reduced if the soil is dressed with applications of top soil taken from forest lands. I am now applying the same treatment to my coffee that I am to the Clifton-on-Bowmont farm—*i.e.*, applications of vegetable matter in various stages of decay, through the medium of jungle top soil in the former case and turf in the latter. Since writing the preceding remark I have been told by Mr. Lillie, the tenant of the Burnfoot farm, that he has no turnip disease on his highest and poorest field, while he has a bad attack on a low-lying field, which is one of the best on the farm. In the former case the land had never been limed, but had an application of marl about seventy years ago. This high-lying land had been left six years in grass before the present crop of turnips had been taken, and there was a good turf. The low-lying field was cultivated on the five-course shift.

Advantages of Deep-rooted Plants.—The results which have been attained from filling the land with deeply-rooted turf are as follows:—The crops ripen earlier. The land is warmer. It dries much more quickly. Carting on the land does little harm to it, or to the young grasses and plants. Superfluous moisture passes downwards so rapidly that all wash is avoided. The land can be much more easily and deeply ploughed and worked. The deep-rooters can penetrate the hardest pans. Weeds are absolutely extinguished, and at Clifton-on-Bowmont, for the last eighteen years there have been none worth removing. No risk of clover failure, though there has been much failure on adjacent farms. No turnip disease, though there has been much in certain seasons, with the exception of one small portion of the land, and that only occurred once. No manure required except some artificials with turnips when first turf is ploughed. As far as we can see at present, no manure is needed when the second turf is ploughed, as the land is then fully charged with deeply-rooted decaying turf.

Products of all crops certain, either in very dry or very wet seasons. More stock can be kept at same cost. They can be kept in much better health owing to the properties of some of the plants used. Less capital is required for working the farm. As the deep roots decay the land is permeated to its greatest depth (chicory will go down from 3 ft. to 4 ft. in fifteen months, and 1 ft. 6 ins. in three months) with vegetable matter. The land can thus be deeply aerated, and more moisture carried into it to the advantage of the land in droughts. In dry weather the land cools sooner, and more dew will be precipitated. By the steady increase of humus, and the deepening and tilling of the soil by roots, the fertility of the land can be continuously improved without additional expense. Manurial matter which has sunk low in the soil can be retrieved by the deep-rooters. Land well supplied with humus retains much heat which would otherwise be lost. It also retains 20 per cent. more moisture than a mineralized soil. It is important to note too that the air passing over a humus-fed soil, would be cooler and moister than air passing over a mineralized soil. The dewfall* therefore would be greater, and when the land throughout the country becomes generally humus-fed, the rainfall would be more advantageously distributed, and fall over a greater number of days in small showers instead of heavy falls of rain, as is the case when land is clothed with forest. Tough, clayey, and unworkable soils, which readily run together, can be ameliorated by the system, and completely altered in character. Finally, roots, by virtue of the acids in them, can utilise portions of the mineral matters locked up in stones. I have now given twenty-five distinct advantages which will certainly be obtained from the adoption of my system. I may add that owing to the want of the means of duly keeping up a good supply of humus in the land the soils of Great Britain are, to a very large extent, in deplorably bad physical condition, and this has been much worsened by liming and the injudicious use of artificial manures.

* From "*The Journal of Board of Agriculture*," p. 499, November, 1907.—"It was found in the course of the experiments with reference to dew ponds that colour affected the deposition of dew to the extent of no less than five times in favour of a pan painted white, as compared with one painted black." Should this experience be correct it follows that a soil darkened with humus will precipitate more dew than a light coloured one.

MANURES USED FOR TURNIPS AT CLIFTON-ON-BOWMONT.—First crop taken after grass—6 cwt. to 8 cwt. of basic slag, 1 cwt. of sulphate of potash, and 1 cwt. nitrate of soda per acre. Analysis, 26 to 30 per cent. total phosphate. Fineness, 80 to 90 per cent. will pass through sieve 10,000 to the square inch. Second crop after oats—5 cwt. to 6 cwt. bone manure per acre. Analysis, 2 to 2½ per cent. ammonia, 32 to 35 per cent. of phosphates, 24 per cent. of which are soluble. If the field seems poor it receives the larger quantity stated, and if in good heart the lesser.

WHY LAND ON MY SYSTEM INCREASES IN FERTILITY, EVEN THOUGH A BREEDING STOCK IS KEPT, WHILE PRACTICALLY NO CAKE IS USED, AND HITHERTO ONLY A SMALL QUANTITY OF ARTIFICIALS WITH TURNIPS.—This is a point alluded to in the letter of a tenant-farmer quoted in the Preface, and has puzzled him, and many others, not a little, seeing that, as he points out, even valuable old pastures quickly degenerate when a breeding stock, or young animals, are kept without extra cake feeding. The explanation is that the old pasture only produces white clover, which is a comparatively small collector of nitrogen; while with my system, once every eight years, a large heavy crop of red clover and kidney vetch is grown, which supplies a large quantity of nitrogen to the soil, while the deep-rooting plants bring into use much mineral matter which is quite out of the reach of the grasses. With these manurial agencies, and the rich turf we can now grow in four years' time, we are able to keep that breeding stock which old grass cannot do without deterioration, because we supply the soil with a large amount of humus. The effects of this are fully enlarged upon by Warrington, Roberts, and other writers. The presence of humus conserves manure (ammonia) in the soil that would otherwise be washed out, and a soil destitute of humus will contain hardly any nitrogen. The fertility of all virgin soils is largely owing to the nitrogenous humus they contain. What plants most require are things dependent on that physical condition of the soil which, with the aid of humus is so fully supplied—air, moisture, and warmth. The importance of humus in all light soils is immense, as it enables such soil to retain manurial matters. Humus also brings into action the inert

mineral matter of the soil. Finally, with the aid of the deeply-rooting plants I use, the humus is in every rotation more and more deeply distributed in the soil, and the area of root range is continuously being so enlarged. These points, and others to which I have elsewhere alluded, fully explain our ability to produce crops which have surprised the farmer alluded to in the Preface, as well as many of his friends.

Decomposition of Vegetable Matter more Rapid on Warm Slopes.—In Keith's "Agriculture of Aberdeenshire," page 637, it is stated that "in thin soils, incumbent on gravel, decomposition of vegetable matter is more rapid than its reproduction; and being, when decomposed, soluble in water, it is carried through the porous subsoil along with the lime, animal manures, and whatever else water can hold in solution. For this reason land of this description having a south exposure is generally more shallow and exhausted than when screened from the sun's heat by an inclination to the north." At the present time, when our farming system requires to be largely remodelled in order that we may successfully grapple with the difficulties of the age, this is a point of considerable importance, and deserving of further investigation, in order to estimate exactly the effects of the various aspects in the case of thin soils overlying porous subsoils, or which have been well drained. In such cases it seems evident that the warm aspects should be kept in grass as long as possible, and, when taken up, should be cropped with turnips, and laid down to grass the year following, as the waste of vegetable matter and manure is far greater when the land is under plough than when it is lying in grass. No experiments have been made that I am aware of in order to determine the comparative loss of nitrates on the various aspects. Dr. Keith's book, which I have alluded to previously (*vide* page 59), was published in 1811, and furnishes us with more than one illustration of the great neglect of Government in failing to keep alive and direct continuous attention to points of the greatest importance to British agriculture. It is constantly being assumed that farmers may be relied on for adopting whatever course will pay them best. There never was a greater delusion. More than one hundred years ago the superiority of cocksfoot to

ryegrass was amply proved. The former, from its superior productive power, is cheaper than the latter. The former tells in the most superior manner on the subsequent crops, and in ameliorating the condition of the soil. But the farmer still prefers the practically dear ryegrass to the cheaper and more advantageous cocksfoot.

ON THE QUANTITY OF CLOVER SEED THAT SHOULD BE USED.—It has been customary in Scotland to sow from 10 to even 14 lbs. of clover with the mixtures used in rotation husbandry. Our usual seeding, which we find ample, is 1 lb. of alsike, 2 lbs. of late-flowering red clover, and 2 lbs. of white clover. With 2 lbs. of white clover we have abundance of the plant, and in one five-year-old grass field it has been abundant throughout. An agriculturist of great experience in Northumberland informs me that he had noticed the rapid disappearance of clovers in pastures when sown in large quantities ever since he could remember anything. Red clover is only a degree more difficult to grow than white, and is liable to fail, he says, from the same cause; but when he used 2 lbs. or 3 lbs. of white clover it gradually increased as time went on. And the dreaded fourth year never came. Were it not that the plants were liable to be destroyed by slugs, in the event of the early summer being wet, he would only sow 1 lb. That was his experience up to 1893, but in a letter received from him in October, 1900, he informs me that he has continued his experiments, and for the last few years only sown ½ lb. per acre of white clover, and no clover of any other description. Our experience this year certainly seems to show that even with 5 lbs. we have been sowing too much. In the case of some acres cut off at the head of the Outer Kaimrig field for planting, at an elevation of about 800 feet, I ordered half of the grass part of the mixture used in the field to be put down in the part severed for the plantation, partly for shelter to the plants and partly as cover, and partly to re-seed the field, as the seeds, from the prevailing wind, would be blown over the land below. But, owing to an error, half of the whole mixture was sown, and it was rather less than half, I am informed. The clovers thus sown in error were rather less than 1 lb. each of alsike, late-

flowering red clover, and white clover. With this small seeding we had such an enormous crop of clover that the plants of the plantation were mostly smothered, and I thought all the grasses must be so too; but these have now sprung through the decumbent clover to such an extent that I have ordered the ground to be continued as an experiment, and not to be replanted for another year. This accidental experiment has, as regards red clover, proved most interesting, as it has been shown that this clover lasts longer than is usually supposed. The land was sown in 1899, and yet there was an abundant supply of red clover in flower in 1903, and I exhibited at a meeting of the Farmers' Club at Kelso on November 20th of that year plants in flower, and about 4 feet long.

THE DOWNWARD PENETRATION OF CHICORY AND BURNET ROOTS.—In consequence of the Kale having washed away part of the bank of a field on the Morebattle Tofts farm, we have this year (1904) easily perceived the value of these plants in opening up hard pans, and acting at once as drainers, aerators, and tillers of the soil. The seed of the plants I am about more particularly to allude to was sown in 1897, the land was hayed the year following, and grazed for three years afterwards, when the field was ploughed up. A strip on the margin of the river was left, and in it were chicory and burnet plants. Two of the former were carefully taken up. The chicory was in flower, and the plant was 5 feet 2 inches above ground, while the root measured 4 feet 5 inches. The root for about a foot from the surface was much crooked, but afterwards went straight down through a very hard clay pan about 9 inches thick (a specimen of which, not unlike a piece of soft rock, is shown at Clifton-on-Bowmont along with the entire plant), and thence downward through a hard clay into the gravel which lay below it. The hard pan and the hard clay beneath it, are, together, 32 ins. in thickness. The root near the surface was 4½ ins. round, and 1½ in. at about 1 ft. down. Another plant was removed, and has also been preserved. This divided into eleven roots close to the surface, each about 1½ inch round down to about a foot from the surface. The main root went down 3 feet 4 inches. I may here mention that I have obtained from the

Continent six varieties of chicory for experiment,* with the view of ascertaining the kind most suitable for agricultural purposes. Chicory lasts in the land longer than is commonly supposed, and where only two pounds per acre were sown eleven and a half years ago, and the land (kept in permanent pasture) has in that time been hayed four times, there is still (1904) a fair proportion of plants in vigorous condition.

A burnet plant taken up at the same time had a tap root descending straight downward through the hard pan to a total depth of 2 feet 2 inches. Near the surface the root was one inch round, and at about a foot three-quarters of an inch. The plant is a very fine one, and shows its suitability for such soils. Its value for hard, dry, shallow soils is well known to those who have observed this valuable plant. It met, I may here observe, with

* These were sown in the garden at Clifton Park on 26th June, 1905, in good, deep soil, and in three months from the date of sowing some of the plants of each variety were lifted, and the roots and leaves measured, with the following results :—

	Length of root.	Length of leaf.
Common Long-rooted Chicory...	18 inches.	22 inches.
Magdeburg Large-rooted do. ...	18 ,,	20 ,,
Brussels Large-rooted do. ...	15 ,,	18½ ,,
Brunswick Large-rooted do. ...	14 ,,	15 ,,
Red-leaved Lombardy do. ...	18 ,,	21 ,,
Improved Large-leaved do. ...	14 ,,	13 ,,

On 7th August, 1906, the plants remaining in the ground, now nearly 14 months old, were taken up. Underlying the soil where the chicory had been growing was found a gravel bed which at the time the plants were lifted was almost as hard and dry as a macadamized road, but in spite of this the chicory roots had gone right down, and were traced to a depth of from 6 to 9 inches through this uninviting medium, and a total length of root of from 26 to 29 inches was thus obtained in less than 14 months. The small fibrous roots had gone further down, but were broken off, as they were too fragile to stand the disturbance of the gravel in which they were located. The four first-named varieties all showed much the same capacity in regard to root penetration, while the two last-named were much inferior in this respect. The variety that has all along been used at Clifton-on-Bowmont, and which has proved so successful there, is the Common Long-rooted or Wild Chicory (the first of the above named varieties). Next to it we would place the Magdeburg variety. The Brussels and Brunswick also seem suitable, but we would not recommend these without seeing further trials on a larger scale.

much attention from agriculturists in England about from 100 to 150 years ago, if I may judge by the long notice of it in the "Complete Farmer," which was published in 1793. Burnet is there recommended as a valuable fodder for winter, and early in the spring, and it is noticed that it not only remains green in hard frosts, but increases in bulk and grows if the winter should be mild. The straw was found to be very useful fodder for horses, cows, calves, and sheep, and the chaff of great value if mixed with any other ordinary chaff. Burnet seed was found to be as good as oats for horses, and for these it found, therefore, not only hay but corn. One of the farmers quoted in the article was satisfied "that there is no better pasture for cows, whether milch or barren, than burnet.' Arthur Young is quoted as follows:— "Experiments have been made in most parts of the kingdom that prove the exhausting quality of rye-grass; its narrow leaf, and fibrous roots, class it in this respect, as well as its botanical arrangement, with corn; but the broad leaf of burnet, and its deep carrot root, indicate the contrary effect; and accordingly, in several trials that have been made, it has been found to ameliorate. The poorest soils in the kingdom agree well with it, even such as are too poor to produce any other herb. The hot pungent quality of the plant has been found exceedingly advantageous to sheep touched with the rot." Another writer (Mr. Pitt) quoted in the article alluded to thinks the plant a good one to sow, instead of ryegrass, with clover or trefoil, being abiding, very early in spring, extremely hardy, bidding defiance to frost, and sustaining the chilling blast of the east wind without fading.

It may be of interest to mention that in Bacon's "Essays," the one entitled "Of Gardens" mentions the plants which perfume the air most delightfully when trodden upon and crushed. These are burnet, wild thyme, and water mints. "Therefore," he says, "you are to set whole alleys of them, to have the pleasure [of the perfume rising around you he means,] when you walk or tread." I may add that we have a Shakesperean reference to burnet in King Henry V., Act V., Scene II.

> The even mead, that erst brought sweetly forth
> The freckled cowslip, burnet, and green clover.

Importance of Laying Down Foul Land at Two Operations.—I have to record this year (1904) one important experience, which confirms the opinion I have elsewhere expressed in favour of laying down land to permanent pasture at two operations, partly because if done at one the land can rarely be supplied with sufficient humus, and partly because our soils are so filled with the seeds of weeds and worthless grasses—notably Holcus lanatus, or Yorkshire fog—that I do not think a thoroughly clean pasture could be created at one operation. In confirmation of this view, I may quote the case of the Island field. This was sown in 1890 (with the little Countridge field, of which it originally formed a part) with 14 lbs. cocksfoot, 5 of tall fescue, 3 of timothy, 3 of hard fescue, 3 of crested dogstail, ½ lb. each of yarrow and poa fertilis, 2 of lucerne, and 2 each of alsike, white, and perennial red clover. In 1898 the field, less the Island portion, which was then fenced off, was relaid with one of our improved mixtures, including the deep-rooting plants. This year both portions of the field were cut for hay, and though the take of grass in the Island portion in 1890 was excellent, the Holcus lanatus was so prevalent that the field at a distance looked white, while the rest of the land, sown in 1898, showed no signs of it, though, as we have seen, it had been laid down six years previously—an ample time for Holcus lanatus to show itself had it been there. These facts show how completely our system of rotation springs and destroys weeds and worthless grasses.

The Agreement of Plants and Trees in Nature.—It is well known that certain trees, shrubs and plants sometimes agree with each other, sometimes disagree, and sometimes seem indifferent as regards their neighbours. For instance, the coffee tree, when grown as it is in most parts of India under the shade of trees, is most particular as to its neighbours. Some trees are an abomination to coffee, to others the coffee seems indifferent, to others again it is markedly partial, and thrives under exceedingly. The same point occurs in the case of combinations of plants in a pasture, and it has been amply shown, for instance, that while ryegrass is hostile to clover, other plants are favourable to it.

EFFECTS OF THE EXCESSIVE USE OF RYEGRASS.—It is well known that almost any opinion, however unsound it may be, is, when once adopted, very hard to kill. Perhaps it is clung to with all the greater persistency because in time it is often assumed to be the result of a long and sound experience. The clinging to ryegrass is no exception. For over 100 years the objections to it have been pointed out, and attempts made to bring about a decreased proportion of it in grass seed mixtures. In Keith's "Agriculture of Aberdeenshire" (1811), which was a continuation of Dr. Anderson's original report of 1793, it was condemned as an exhaustive grass, and it is recommended that landlords in their leases should limit its use, while for poor land it was said to be one of the worst grasses ever known. William Curtis, in his Practical Observations on the British Grasses—London, 1805—hits the origin of its use when he says that it was probably "owing to its being a common grass whose seeds were easily collected." He also notices that Holcus lanatus was the next grass, the seeds of which were collected and sown, and obviously for the same reason. Like Keith, he commends ryegrass for rich meadows, but condemns its use for upland pastures and dry situations. The writer of the article on Pasturage and Agriculture in the "Encyclopædia Britannica" for 1797 considers ryegrass unfit for pastures that are to lie for more than two or three years. Sinclair, as we have seen, writing in 1825, limits the use of ryegrass for permanent pasture to 1-20th of the mixture, while for the alternate husbandry he advises a mixture of three-fourths cocksfoot, the remainder of the mixture to consist of six grasses and clovers, of which ryegrass was one. In 1833, Mr. Lawson, of Edinburgh, took up the subject, and carries us back to the original reasons for using this grass—namely, that the seeds of other grasses were difficult to obtain, which was undoubtedly the case. The effect on British agriculture by his recommending a large use of ryegrass in grass mixtures was most unfortunate, and I have heard one of our most intelligent farmers say that had cocksfoot been used instead of ryegrass in the rotations, their difficulties would have been much lessened, for cocksfoot in three years provides much vegetable matter to add to the humus of the soil, and it is to the absence of this humus, as I have frequently pointed out, that we must almost entirely

ascribe the ruinous decline of fertility in British soils. The ryegrass question seems subsequently to have gone to sleep till 1882, when my late friend, Mr. C. Faunce de Laune, of Sharsted Court, took up the subject in a valuable and widely-known paper, which was published in the *Journal* of the Royal Agricultural Society of England (Part I., No. 35) in 1882. This article, as is well known, not only aroused attention to the subject of ryegrass, but called attention to the enormous adulterations in the grass seed trade, and thus paved the way for much of what has since followed, and, as Mr. Hunter points out (*vide* p. 80), if Mr. de Laune had not gone back to the teaching of Sinclair to find out the truth, we should probably have been pretty much where we were twenty years ago. But the evils arising from the excessive use of ryegrass have since been found to be far more extensive than was originally supposed, and if the reader will turn to the paper I delivered at Cambridge in 1904 (*vide* Appendix IX.) he will see that the greatest evil lies in the effect it has of diminishing the clover, with which it is usually associated—effects which have been fully proved, as I have shown elsewhere, and which have been proved again by the experiments of the Fifeshire Agricultural Association, which show that the amount of clover rises or falls as ryegrass is diminished or increased. But, perhaps, one of the best evidences of the small amount of red clover produced when it is associated with ryegrass has been met with on this property, one of the tenants on which makes annually large purchases of ryegrass and clover hay from various farms in the neighbourhood, and for many miles around. I have constantly observed and inquired into these purchases, with the view of noting the proportion of clover that appears with the ryegrass. An occasional cartload may show a fair amount of clover, but if the fields in Scotland generally (and I have no reason to suppose that things materially differ here from the rest of the country) show as little clover, then there can hardly be said to be any scientific rotation crops in Scotland at all—in other words, the alternation of crops which derive nitrogen from the air with those which must derive it from the soil. All the clover losses may not be attributable to the ryegrass, but that a very large proportion of these are has been amply proved by the experiments made on the subject. I know of nothing more striking in the whole history of the neglect

of agriculture by the British Government than the fact that it is solely from the want of Government experimental farms that such a vast injury should have occurred to our soil, for, had they existed, farmers would have been duly warned of the evils arising from the excessive use of ryegrass, and the immense losses that have ensued from failing to acquire atmospheric nitrogen, and the humus to be derived from clover roots, would have been largely averted. In this connection it may be added that, had my system of farming been pursued, a large proportion of the sums paid to the foreigner for nitrates would have been saved.

General Success of the System.—This has been shown most conspicuously in the case of the Inner Kaimrig, a field pronounced by a very competent judge to be, when I took it in hand, not worth 5s. an acre, and, by the former tenant, the worst field on the farm, a long ridge of it being black moorland soil. And yet this field, now (1904) young grass (sown up with a crop of oats in 1903), has this year kept more stock than all the fields of an adjacent farm, the land of which is far superior in quality and situation. These aggregate over 87 acres, while the Kaimrig field is only 25 acres. The field* has never been manured since it was enclosed from the hill about 70 years ago excepting with some artificials for the turnips, and, as shown in the Preface, there is practically no cake fed on the farm. This field has far exceeded my utmost expectations, and is a most valuable practical illustration of what poor, worn-out land is capable of producing if you clothe it with a deeply-rooted turf which has been built up on a strong leguminous foundation of clover and kidney vetch.

Next to the Kaimrig lies the East Countridge field, now (1904) in turnips out of grass. Though for the last two years I had successfully grown on a small scale turnips without any manure, this is the first whole field in which I have had the moral courage to grow this crop without manure of any kind excepting turf.

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* From April 13th to July 23rd an average of 2½ ewes with double lambs were kept per acre, besides 20 rams for six weeks. From Aug. 6th to Nov. 1st an average of 4 ewes an acre. From Nov. 1st to 20th an average of 2 ewes per acre. The field could have kept much more stock, but we always graze moderately the first year.

The results have been most satisfactory, and competent practical judges declare that the crop could not be surpassed.*

The Bank field, now (1904) four years old, shows a fine turf full of white clover, the presence of which in quantity is always a sign of a thriving pasture. According to my system, this field ought to have been ploughed up at the close of the year 1904, but the turf has been so good that the field has been left year after year in grass, and it is still (1907) unploughed (*vide* p. 165).

Next to the Bank field is the Harewells field—a steep stony field—which shows results almost more remarkable than those obtained in the Inner Kaimrig—a crop of hay (first year's grass) of about two tons an acre followed by a fine aftermath.

I desire to call particular attention to these four fields, for they illustrate the chief points of my system, and, by the results prove its value beyond all possibility of doubt. The beginning of the system, and indeed that on which it entirely rests, is illustrated by the Inner Kaimrig, which has produced a heavy crop of Leguminosæ—clovers and kidney vetch—to feed the grasses sown with them, and thus form them into a rich turf. With the grasses and Leguminosæ are the strong and deeply-rooting chicory and burnet, which keep the soil open—in other words, till and therefore aerate it continuously, till the turf is ploughed up, while the strong and profusely-rooted yarrow adds at once to the value of the pasture and the health of the stock, and leaves behind a large store of vegetable matter. The continuation of the system is to be seen in the shape of the turnip crop in the East Countridge field; a further result of the rotation is illustrated in the Harewells field; while the ultimate result is shown in the four-year old pasture of the Bank field, which, as we have seen, will yield a fine and deeply-rooted turf to commence again our rotation system. The cereals and potato crops are always good, and, indeed, the land is now so stored with humus that it is impossible to produce an inferior crop no

* Note, 1907.—Though I have proved from growing a splendid crop of turnips without any manure other than ploughed down turf, I do not recommend that, from climatic considerations, this should be generally attempted, because, though it would be quite successful in a favourable season, the crop would often require the stimulus of artificial manures to force the growth of the young plants.

matter what the character of the season may be; and we have had several seasons of extreme drought, and one at least (1903) of extreme wetness. For the convenience of the reader I may repeat that our rotation begins with turnips out of grass, oats, turnips, barley or oats with seeds, and then four or more years in grass according to circumstances. Though we have adopted this system, I find that there are in some cases practical objections to it in connection with the labour of the farm—the system giving insufficient employment to the people at one time, and too much at another, but this may be obviated by beginning the rotation with oats instead of turnips in the case of one of the fields, or even all. I consider, however, that it is of importance to begin the system for the first time as regards each field with turnips, in order to get the land thoroughly clean. I may add that whatever minor disadvantages may arise from departing from our rotation—turnips, oats, turnips, and barley or oats with seeds - the great point of deeply filling the land with humus, and tilling it with the agency of roots, would still be maintained by using my mixtures, and keeping the land four or more years in grass. These are the dominating points of the situation, and the order of the crops in the rotation is a matter of comparatively minor importance, though the reader must clearly understand that the best results can only be attained by a strict adherence to our system of rotation.

THE FINANCIAL RESULTS WHICH MAY BE OBTAINED FROM THE SYSTEM OF FARMING AT CLIFTON-ON-BOWMONT.—I have been often asked to publish the accounts of my farm. As I have no desire to mislead the farmer (an evil that might often ensue, as was pointed out to me lately by a tenant farmer of great experience), I prefer not to do so. In Chapter VIII. I have given some general financial results regarding the system on which, I think, landlords should farm their own land. The object of my work is not to exhibit my skill as a stock farmer, or the want of it, as the case might be, but my skill in most economically producing cereals, potatoes, and food for stock—in other words, the introduction of an improved farming system which is calculated to attain these ends. To mix this up with

the stock department of the farm would be to introduce an element of the greatest uncertainty, as it is an element which fluctuates all over these islands. Each farmer must observe what can be produced from the soil by my system of farming, and apply to the conditions of his own holding my principles and system, with whatever modifications may be suitable to his climate and present circumstances. All that the farmer requires to do is to visit one of our young grass fields, in which he will always find a large crop of clover and kidney vetch, which is the indispensable base of the system. The steward carries a crop book of each field for the last 20 years, so that the visitor can see exactly what the field has been doing, and how it has been treated. The steward also carries a seed book, showing cost of seeds and the mixtures used, and the visitor can learn from the shepherd what stock the field has kept. This year (1904), for instance, the Inner Kaimrig—25 acres—has kept as much sheep stock or rather more than the grass fields aggregating 87 acres of the adjacent farm, which is much better land, by the way, but which is farmed on the old five-course system, and on which the generally used ryegrass and clover mixtures have been sown, and I have no doubt this is a difference that would pretty generally be found to prevail in Scotland. A reference to Rothamstead experimental field, devoted to the rotation of crops, will show him how all the subsequent crops are benefited by the manurial matter left behind from a large crop of the Leguminosæ, and for evidence of this he can see the turnips, four years' old grass of fine quality, cereals, and potatoes, all grown without manure other than of the turf grown on the land, and only aided by the manure left by the sheep and the dung of lean cattle, which last is generally applied to the nearest fields to the steading, all the more distant fields having to depend solely on the turf grown on them. The quantity of cake used is so small that the farmer quoted in the Preface considered it to be practically none. What the farmer could keep in the way of stock with the aid of such crops grown as cheaply as mine have been, and what he could make out of the cereals and potatoes, he must calculate for himself, with reference to his own surroundings, and no publication of all my profits could aid him, though it is just possible it might mislead him, seeing that, obviously, my results might

be much worse or much better than a farmer could obtain who imitated my system. Confucius, the Chinese philosopher, once said:—"If I show one corner of a subject to a man, and he cannot see the other three corners for himself, then I can do nothing with him." In the same way it is only necessary for the farmer to visit one of my young grass fields, which are always full of Leguminosæ, and if, after going into the cost of production, he cannot see for himself all the consequential results which must arise from such a field, then I can do nothing with or for him.

But there is another and most important financial point to be considered. Farming, like every other business, consists of a capital account and the profits that may be made out of capital. It is of obvious importance that stock should be carefully taken of the latter—that it should be seen whether it is advancing, standing still, or declining. Landlords' capital mainly consists of soil, and the condition of the soil mainly depends on the amount of humus it contains. About 100 years ago Scottish agricultural capital was on a sound footing, because the system pursued maintained the humus of the soil (*vide* paper delivered at Cambridge, Appendix IX.). It is in an unsound condition now, because from continuous liming and the use of artificial manures the humus of the soil has immensely declined (hence the numerous complaints of the exhaustion of the soil), and is declining steadily except in those rare cases where enough farmyard manure can be obtained to keep up the supply of humus. The object of my farming system at Clifton-on-Bowmont is to show how Scottish agriculture may be restored to its originally sound position—not only to replace, but to steadily increase, the humus of the soil, and render the farmer, as he once was, independent of the use of artificial manures, though, as I have elsewhere pointed ont, these may still be used under certain circumstances to a moderate extent. In other words, my farming system is directed to restoring the capital of the landlord to its originally sound and safe position, to lessen the expenditure at present required by the tenant, and place all his crops in a safe position for contending at once against foreign competition and vicissitudes of climate. How these ends may be achieved most economically has been shown at Clifton-on-

Bowmont, and our agriculture never can be restored to a sound condition unless the principles carried out there—principles the soundness of which are admitted all the world over—are universally adopted in these islands.

PROFESSOR BARNES, TRINITY COLLEGE, DUBLIN, writes:—

"I have been using Kidney Vetch, Burnet, and Chicory in my laying-down mixtures for several years, and have not found either of the two former to be very deep-rooted. Kidney Vetch always did very well with me for the first year, but failed completely afterwards; and I have no doubt but that it will not last on a soil deficient in lime, as mine is. I have therefore given up using it. I have observed that in this country it never grows naturally except on limestone soils, and on such I would certainly recommend its use. In many of Mr. Elliot's fields it looked very thin after the first year. As to Burnet, sheep are very fond of it, and eat it so closely that it never gets a chance of growing to any size, and therefore makes but little show in the herbage. Chicory is a very deep-rooted plant, and does well whether the soil be deficient in lime or not, and I use it extensively. I am using at present the following seed mixture for one year's meadow and two years' pasture:—

	lbs.		lbs.
Cocksfoot	8	Rough-stalked Meadow Grass	2
Perennial Ryegrass	6	Broad-leaved Red Clover	1
Italian do.	3	Perennial Red Clover	2
Meadow Fescue	4	Alsyke Clover	1
Tall Fescue	2	White Clover	2
Tall Oat-Grass	2	Trefoil	½
Timothy	2	Chicory	4½

Total, 40 lbs. per acre.

My soil is a gravelly loam, about 10 inches deep and very dry. On stronger and moister land I would certainly include Meadow Foxtail in the mixture. I have a very high opinion as to the value and necessity of humus, but I think that where a soil is deficient in mineral ingredients, a moderate application of suitable artificials will expedite the production of the clovers and grasses, and therefore increase the quantity of humus in a shorter time than would otherwise be the case."

THE PURCHASE OF GRASS SEEDS.—It is most important that the farmer should buy his seeds separately and mix them at home, because a careful observer may then easily see if each kind of seed is either mixed with other grass seeds or with weed seeds, whereas if they are mixed by the seedsman, the purchaser cannot readily detect in the mixture either a greater proportion of the lower-priced seeds or weed seeds. It is important that the farmer should each year ascertain the current prices of seeds, so as to make up his mixture in the most economical way. Even a seed usually expensive may become in a particular season comparatively cheap. This, for instance, was the case one year with Tall Fescue, and I therefore increased my order by several pounds per acre for it, and used less of another of the seeds of the mixture.

I have shown that the farmer should never purchase mixed seeds. It will be found that if he buys them mixed, he can always get them at a lower price than if they are bought separately and mixed at home, because in the former case a large supply of the cheaper kinds of seeds can be supplied in the mixture without much fear of detection, and a considerable proportion of weed seeds as well. It is a not uncommon practice of farmers to bid one seedsman against another, till a price is reached so low that no good seeds could be supplied for the money except at a loss to the vendor. The farmer then goes home happy and thinks he has done well, while in reality he has been swallowing the cow and choking on the tail—the cow meaning his total expenditure on the land for rent, taxes, working, and other expenses, while he hesitates to swallow that tail which is necessary to complete his transaction for the year, and for as many years afterwards as he wishes his land to be in grass. In other words, if he takes pains to see that he gets the best grass seeds, and mixes them at home, he may be certain of getting the best results from his labour and expenditure, while by putting down inferior seeds he is sure to be a comparative loser.

COMPARISON BETWEEN THE TURF FROM OLD PASTURE AND THAT FROM DEEP-ROOTING PLANTS.—If you cut up and examine a turf from an old pasture it is very shallow as compared with a

turf of only four years of age composed of the deep-rooting grasses and plants recommended in my mixtures.

THE MIXING AND SOWING OF GRASS SEEDS AT CLIFTON-ON-BOWMONT.—The grass seed mixtures are usually sown at Clifton-on-Bowmont about the first week in May, on the growing oats or barley which have been put in two or three weeks previously, and our success has been invariable. It will be remembered that Clifton-on-Bowmont farm (not including the hill pasture) is from 400 to 800 feet elevation, and is in a rather late district. It has been our practice to sow the grass and clover seeds all in one mixture, at one operation, using an 18 feet seed sower for the purpose. The same seed sower is also used for sowing barley and oats. The mixing of the seeds is done on a smooth cement floor. Each species of grass and clover seed, chicory, burnet, &c., is spread evenly on the floor, one kind above another, and then the whole is turned over with shovels several times, from side to side of the room, until the whole forms a perfect mixture. The mixture is then put into bags ready for sowing, care being taken not to allow the heavy seeds to settle, or be unequally apportioned.

THE WORK OF THE BOARD OF AGRICULTURE:—

1. In grants for agricultural education and research the Board spends from £7,000 to £8,000 a year.

2. Nearly all the suggestions and experiments given in their reports tend to involve the farmer in some expenditure beyond what he at present incurs.

3. But, as a rule, farmers have no money to spare for any extra expenditure, and the few who have are afraid to risk it, as the outlay might be lost owing to defects of season or a fall in prices.

4. It must, then, be clearly proved to the farmer that any suggestion made to him must yield distinct advantages, combined with a reduction in the present cost of production, and a diminution of risks as regards crops, stock, and from adverse seasons.

5. What is the essential basis of the highest agriculture? It is that the soil should contain a considerable proportion of vege-

table matter in various stages of decay. It is this which gives the great value to virgin forest soils and to newly-enclosed pasture lands.

6. But if, and when, this vegetable matter declines to a low level, which it, of course, soon does unless supplied in some way, then all the difficulties of agriculture begin. The plant is involved in them because its roots cannot, as a rule, readily penetrate soil which is not kept open by humus; the agriculturist, because he has to spend more money in cultivation and manure, and even then obtains results far inferior to those which can be obtained from a soil well supplied with humus, if the land is aided by a slight degree of cultivation and a very small expenditure in manure. Then when the land is deficient in humus, as nearly all our cultivated lands are, the risks from defective seasons increase, there is less food for stock, and plants are more liable to disease and to suffer from the attacks of insects.

7. With the great evil of defective soil conditions which underlies our agricultural difficulties the chemist cannot grapple, nor can all the education and experiments on which the Board spends from £7,000 to £8,000 a year.

8. On the Clifton-on-Bowment farm I have grappled with our agricultural difficulties *as to system* (though improvements are yet to be made before it can be brought to perfection), but, *so far as the public is concerned*, I have only grappled with them on paper.

9. From the numerous mistakes liable to be made in working the system, and in matters which, though to the uninitiated apparently trifling, largely influence results, I feel sure that much disappointment and loss must ensue unless those desirous of adopting my system have opportunities of studying it in the field in all its details, and are practically shown the importance of carefully attending to them.

10. For the general adoption of the system three things are absolutely necessary—(1) That farmers should be able to study the details of my system on a farm conducted as mine has been, on a system that is within reach of any ordinary farmer; (2) that he should have the financial results clearly proved to him; and (3) that seedsmen should be compelled by Act of Parliament to guarantee the purity, trueness, and germinating power of the seeds they sell.

11. From studying Arthur Young's great unpublished work, and observing, from other sources of information, what valuable experiences and discoveries have been gradually lost sight of from the inertness of our Government in failing to record, and practically illustrate by demonstration farms, facts of the greatest value to agriculture, I feel confident that the views I have above expressed are sound.

12. From the numerous visitors to Clifton-on-Bowmont I have received most gratifying opinions as to the value of my work. An agriculturist, whose opinion I highly value, in writing to me lately, said—"What I saw the other day convinces me that you have revolutionized the methods hitherto pursued, proved to the hilt that the old are very inferior in results to those you advocate, and I cannot but believe that sooner or later—the old dies hard—what you have so persistently laboured at will be generally adopted."

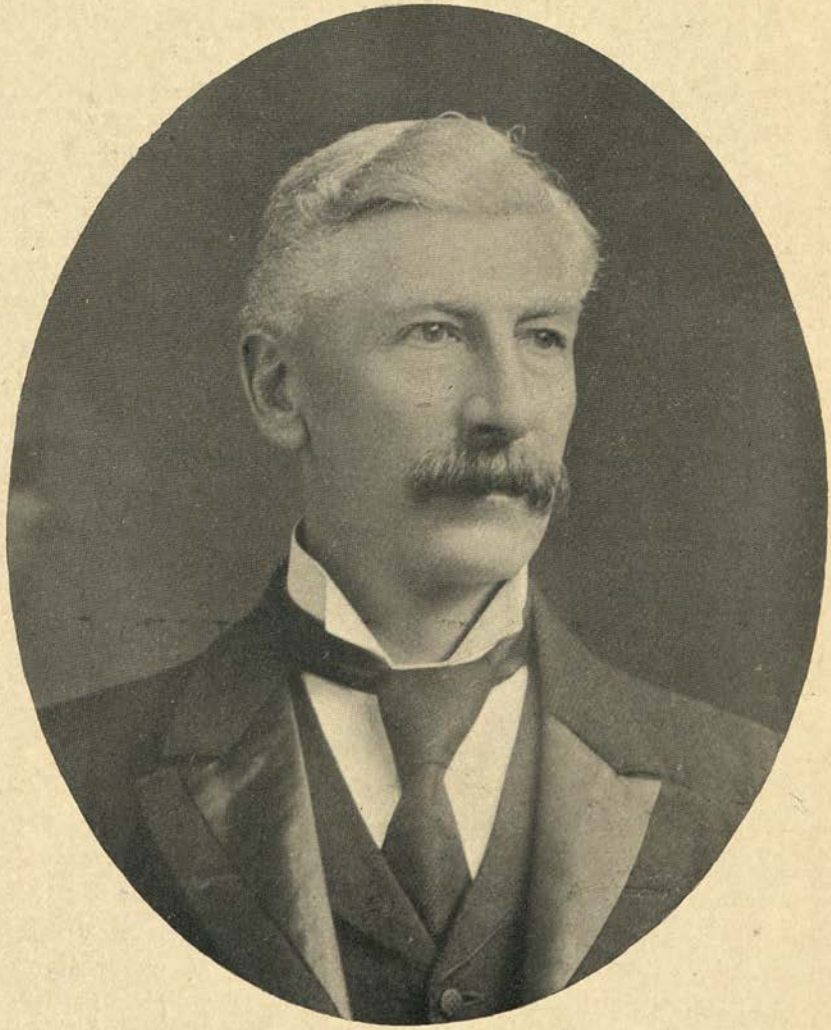
13. Though work on the lines of the Board, as shown in their reports, cannot accomplish the ends indicated in par. 10, I by no means wish the reader to infer that the work of the Board is of little value. All that I wish to insist on is that it never can be of the value that it might be unless it is accompanied by practical examples like those on my Clifton-on-Bowmont farm—examples which show how agricultural improvements may be carried out, in some cases without additional cost, and in others with a considerable saving of the expenditure at present incurred.

CONCLUDING REMARKS.—When visiting Clifton-on-Bowmont one day with an intelligent gardener, I remarked—"Is it not wonderful to see such a fine crop grown on such poor soil?" He replied—"Give me a good turf, and I don't care what the soil underneath it is"—a point he practically illustrated as to the value of turf by robbing my park of it whenever he could, though he had full command of all kinds of manures. I may remind the reader here of the quotation on the title-page, where it is declared that "TO RAISE A THICK TURF ON A NAKED SOIL WOULD BE WORTH VOLUMES OF SYSTEMATIC KNOWLEDGE." This is what has been done at Clifton-on-Bowmont. In little more than two years we can now raise a turf which, at a little distance, looks like old pasture, and on a close inspection might be taken for five-year old grass, while in five years we have

grown pasture that no one could distinguish from old grass. I much regret not having kept note of the remarks made by agriculturists to the amount of one hundred a year—who have visited the farm. On remarking to a visitor that some of them had said that what they saw had been a revelation to them, he said—"And it is a revelation to me too." When lately showing an old agriculturist from East Lothian the Kaimrig field (*vide* page 29) he finally observed, with a strange mixture of wonder and annoyance in his face "We have been like children." In some instances we have certainly trebled the letting value of the land. Dr. Voelcker (chemist of the Royal Agricultural Society of England) remarked when visiting the farm in 1904 that I should have kept in each field an untouched patch to show what the land originally was, for that it was now difficult to believe how bad it had been. What the tenant who had for long occupied the farm declared to be the worst field on it is now so changed that farmers will not believe in its ever having been bad land. But just as land of originally good quality, when mixed with a suitable proportion of vegetable matter, may be turned into the worst possible land when this necessary agent has been exhausted, so may the very worst land be raised to the value of good if you "raise a thick turf on the naked soil," and if we keep on raising another before the preceding one has been exhausted we shall have done all we can to promote the fertility of the soil, and, therefore, the condition of agriculture. I once said to an old tenant on the estate - "How much more stock can you keep on your young grass fields since you have adopted my advice as to altering your grasses?" "I can keep," he said, "one-third more stock," which, I need hardly say, doubles the value of the land. "Now," I said, "I wish to ask you another question. Did you not at one time consider me to be (the fate of most innovators at first) a madman?" He laughed heartily, wagged his head from side to side, and said - "Oh, no, no, no!" but in a tone which meant "Yes, yes, yes!" It may not be uninteresting to mention that it was a remark made by this tenant which led to much of the valuable results we have arrived at. He once said to me, many years ago—"What we want is something green and sappy to go with these grasses when they dry up in summer." "You want,

then," I remarked, "something which corresponds to the dry grass as turnips do to hay." "That's just it," he replied. I then sent to Mr. James Hunter, of Chester, for a list of all those plants which stock would eat, and which would not dry up in summer, and my subsequent study of the consequential results arising from their use showed me their immense value in at once tilling the soil, adding to our stores of reliable food for stock, deeply manuring the land, and improving the health of crops and stock.

One word more. There are large areas of land in these islands steadily going from bad to worse. They are not suitable for permanent pasture, and still less are they suited at present prices for profitable arable cultivation under the old system. Much of what is still kept in arable is steadily declining in value, and no wonder, for, to quote again my late friend, Mr. Faunce de Laune, "farming, as it is practised now, is more often the means of destroying natural fertility"—he means by running out all the vegetable matter in the soil—"than adding to it, and it is therefore no wonder that the land becomes impoverished." From the impoverishment of the soil, and large areas being allowed to what is called "fall down" to profitless pasture, cottages are being rapidly emptied, and the whole conditions and prospects of our agriculture are most unsatisfactory. How this condition of things may be ameliorated I have shown in these pages. It now only remains for the Government to propagate what I have eventually, after many years of labour, proved to the hilt.



Dr. J. A. VOELCKER.

APPENDIX IV.

NOTE BY DR. VOELCKER ON COMPARISON OF THE SOILS OF OLD CHEVIOT TURF AND FIVE-YEAR-OLD PASTURE.

An examination which I made of two samples of soil from the Clifton-on-Bowmont farm—the one being from old hill-side Cheviot turf, which has been unploughed from time immemorial, and the other from a spot only a few yards off the other, but on which Mr. Elliot has adopted his new system—yields results which may have some interest.

The new pasture was five-year-old.

The old hill-side turf showed on the surface some coarse, mostly dead, tufty grass, which could in great part be pulled up easily with the hand. Then came a top-layer of black peaty matter extending 4-5 inches deep, and in this was a mass of roots crowded together, but not passing down freely and regularly into the subsoil. On testing the peaty portion with litmus paper, it was found to be extremely acid. It also held a considerable quantity of moisture. The soil below this retained to some extent the acid character, and then a more stony subsoil was reached.

The five-year-old pasture, on the other hand, had on the surface a very fair covering of good grasses, cocksfoot being prominent. The roots from these grasses and other plants did not collect together in a matted form, as was the case with the old Cheviot turf; but they went down into the subsoil strongly and regularly. There was no accumulation of humus matter in excess, true soil being formed almost to the very top. The re-action of the topsoil to litmus paper was only slightly acid, and this disappeared entirely in the subsoil. The soil was not nearly so spongy and moisture-holding as was the Cheviot turf, but seemed in a good physical condition throughout.

Portions of the different layers, and average samples of the whole, were taken in the case of both soils, and the vegetable

matter, moisture, and nitrogen determined. The principal results were:—

	Cheviot Turf. Per cent.	*Five-yr.-old Pasture.* Per cent.
Vegetable (organic) matter in average of soil to 9 ins. depth	10·05*	9·54*
in *first* inch	38·10	12·87
„ *second* „	15·04	9·70
„ next 5 inches	9·65	8·71
*containing nitrogen	·336	·298
Moisture—		
in topsoil	64·76	41·82
„ subsoil	37·46	25·94

From these results it appears that though the old Cheviot turf has been down so long, and has had such a time for the storing up of vegetable matter, yet, on taking the soil to the depth of nine inches, there is not half a per cent. less vegetable matter in the ploughed-up and cultivated land than in the old turf. This, and the very different appearances presented by the soils, led me to examine further, and see in which part, or layer, of the soil the excess vegetable matter was. The figures show that this was by far the most prominent in the *first* inch—*i.e.*, where the matted roots were, and with consequent absence of real soil formation.

Still more pertinent is the difference shown by the two samples in respect of the moisture they held, the Cheviot turf being spongy and moist throughout the whole topsoil, while the five-year-old pasture was uniform soil throughout, and seemed well drained, and not in stagnant condition like the other. This, of course, carries with it most important consequences as regards the health of stock grazed upon the respective pastures. Though the figures do not show that there is actually more, or even as much, vegetable matter in the five-year-old pasture as in the old Cheviot turf, the form in which it exists, and the general condition of the soil induced by its presence, are vastly superior in the case of the newer pasture. I should describe the old Cheviot soil as one which was sour through accumulation of vegetable matter and retention of moisture, producing an acid and unhealthy condition of the soil, preventing its proper aeration and drainage, or the healthy penetration of the roots into the subsoil. On such accu-

mulation of acid matter alone coarse and inferior grasses would grow, thrive for a time, and then die down, in part or whole, adding further to the matting of dead or dying roots. On the five-year-old pasture, on the contrary, there is not this stagnation: the vegetable matter is, by aeration, influence of drainage, cultivation, &c., brought into assimilable, instead of unhealthy, condition, and soil formation, instead of humus accumulation, is the result.

These points, to my mind, bear strong evidence to the superiority of the newer pasture, and to the efficacy of the system which Mr. Elliot pursues.

J. A. VOELCKER.

November, 1900.

Second Note by Dr. Voelcker.

In November, 1900, I appended to Mr. Elliot's new edition of his book, "The Agricultural Changes required by these Times," a note on the examination of some soils from the Clifton-on-Bowmont farm. In these I made a comparison between an old hill-side Cheviot turf and an adjoining one laid down five years previously with Mr. Elliot's mixtures. The general bearing of the observations and analyses was to show that, though the old turf had accumulated rather more vegetable matter and nitrogen, yet this was confined practically to the very top portion, which consisted of a matting of roots and rootlets, and which held moisture to a considerable extent, but did not allow of its percolation to the lower layers, or the ready penetration of the roots of the grasses into the subsoil.

Since that time I have had under observation other fields at Clifton-on-Bowmont laid down by Mr. Elliott, and these I have visited regularly, watching their progress as compared with that of the old turf. The question arose in this connection whether, as the pasture goes on from year to year, and as it improves (as is quite clear to any one having it, as I did, under regular observation) the soil itself becomes deprived of, or else is enriched in, organic matter and nitrogen. For the purpose of ascertaining

this, if possible, I have had samples taken each year of the turf and soil from a particular spot, and I have examined and compared the several blocks thus successively removed. The field in question was Bank field, laid down in 1900, and samples have been taken in 1901, 1902, 1903, and 1904. The sample taken in the first year (1901) showed the same characteristics as compared with the old Cheviot turf as were instanced in my note in November, 1900. There was no matting of roots at the surface with accumulation of organic matter there, but the roots showed themselves penetrating regularly downwards.

In the second year (1902) there was not noticeable any great change; but, still, there was some increase both of root growth and of the extent to which the vegetable matter penetrated down into the soil.

In the third year (1903), however, there was decidedly more root growth, and on this occasion a second sample—of the second depth of nine inches of soil—was taken and analysed, this showing that organic matter, together with a considerable amount of nitrogen, existed in these lower layers.

In 1904 (fourth year) a further sample was taken, and this very clearly showed a great increase in the amount of root growth, and the penetration of the humus to a greater depth. Moreover, the character of the soil itself had considerably altered, it being, as compared with the samples of the earlier years, much more friable and in generally nicer condition. The analyses of the various samples are appended, each being taken on the first six inches of soil from the surface, except the second sample of 1903, which was of the six inches taken immediately after the removal of the first layer of nine inches. The figures are :—

	1902.	1903.		1904.
		1st depth.	2nd depth.	
	Per cent.	Per cent.	Per cent.	Per cent.
Organic Matter	8·98	8·96	6·03	9·61
Nitrogen	·263	·300	·210	·285
Equal to Ammonia.....	·319	·364	·255	·346

THIRD NOTE BY DR. VOELCKER.

The inquiry has gone on, a fresh sample of the soil being taken each year until 1907, the spot chosen being in each case close to where the previous year's sample was obtained. The soil, after reaching my laboratory, was carefully compared with the samples of the earlier years, and the general appearance, nature of surface growth, colour, depth of rooting, and state of moisture observed. Smaller samples of the first six inches from the surface were then taken, dried, and prepared for analysis. The following table gives the analytical results for each year :—

(Soil dried at 212° F.).	1902.	1903.	1904.	1905.	1906.	1907.
	per cent	per cent	per cent	per cent	per cent	per cent
Organic Matter	8·98	8·96	9·61	8·62	8·50	9 54
Nitrogen	·263	·300	·285	·236	·281	·288
Equal to Ammonia.....	·319	·364	·346	·286	·341	·350

It cannot be maintained that more than general conclusions can be drawn from the above figures, for there are, necessarily, features which prevent the soil taken one year from a certain spot being strictly comparable with that taken from an adjoining spot in a different year. But a general review of the figures makes it abundantly apparent that the soil is not undergoing deterioration in respect of organic matter or nitrogen; but that in 1907 it was even richer than it was in the earlier years. Further, the analysis of the second depth of six inches of soil, taken in 1903, shows that in the lower layers there were good supplies both of organic matter and of nitrogen.

The main point to be remembered, however, is that the vegetable matter, instead of being, as shown in the case of the old Cheviot turf (see note of November, 1900), stored up in the top surface and remaining there more or less in an inactive and useless state, is, under the system pursued by Mr. Elliot, becoming distributed more regularly throughout the soil, and is at the same time being rendered active and available. The same holds good, as a consequence, with respect to the nitrogen, this being largely derived from the organic matter.

The mere richness of a particular layer in organic matter and in nitrogen—as shown by the figures of an analysis—is not

enough to indicate whether this be beneficial or not, for, as pointed out in the case of the old Cheviot turf, these constituents may be present in the form of a spongy infertile mass of roots accumulated at the surface. The real test is whether the total amount of organic matter and nitrogen in the whole mass of soil constituting the growing area is increased, and whether this is of such nature as to be available for use by growing plants. Hence, while the analyses as given above show that the soil, as a whole, is by no means deteriorating, but rather the reverse, even more abundant testimony is borne to this fact by the observations which I have made from year to year of the samples of soil submitted to me. This comparison has been a most instructive one, and, going as I have done through the whole series from 1902 to 1907, I cannot fail to be greatly struck with the marked improvement which has gone on from year to year in the character of the soil. The gradual penetration of the humus to the lower layers has been very apparent, and with this has come about the deeper penetration and more free growth of the rootlets of the plants. When I see what the soil originally was and what it is now, I can only describe the change by saying that "soil has been formed." I cannot say, of course, that the stones have disappeared! But they have at least become less obtrusive, and more surrounded with good soil, and the whole has a more healthy appearance and is more what soil should be. This change I cannot but attribute in chief measure to the system which has been pursued by Mr. Elliot.

J. A. VOELCKER.

January, 1908.

APPENDIX V.

SHELTERS.

That shelter is "half meat" (*i.e.*, food) is an old saying on the Borders, and, in confirmation of this, I may mention that my late friend, Mr. Faunce de Laune of Sharsted Court, found that a sheep shelter he had put up paid, in fourteen days' time, interest on the outlay incurred in making it. He had two lots of sheep, which were being fed on oilcake, and which were regularly weighed, and the increase of weight in the lot that had the benefit of the shelter was such that it, in a fortnight, yielded the financial result I have stated. Although, however, the facts previously given are well known it does not seem to be, at least practically, known that shelter affords a very large increase in the growth of food for stock. I have long been aware of this, but was more particularly struck with it this year (1904) in the case of the Harewells field, which is fully protected on one side by a plantation, and partially so on the other. The field was young grass, and was cut for hay, and it was interesting to note that as you got away from the reach of the shelter the yield of grass gradually declined towards the unprotected portion of the field, and, probably, to the extent, in the most central portions, of about 25 per cent. But if the stock and the grass require shelter the plantations, when young, equally require it, and perhaps in a greater degree, and it is of obvious importance to devise some means of at once sheltering stock, grass, and plantations, till the last has grown sufficiently to afford the desired shelter. The following remarks with reference to shelters for hop gardens and orchards have been supplied to me by the kindness of a friend, and I have no doubt may be useful for the information conveyed, and as a means of calling attention to the whole subject, so that improved methods of sheltering young plantations, stock, and grass may be devised.

With the view of providing practical protection for a young plantation I am experimenting with larch poles about 12 feet in height, and 6 feet apart, with stays on the sides from which

we have our strongest prevalent winds. From pole to pole I am putting stretches of rabbit wire netting, and such a structure* will sift the wind (to use a Kentish expression), or divide it, and so break its force to a considerable extent, and for a considerable distance. I shall probably connect the poles with rope or wire, besides staying each pole on either side. Should rabbit mesh prove so small as to get snowed up, a larger mesh might be used. When the plantation has grown up sufficiently to afford the desired shelter the windbreak might be removed, and used for another plantation. I may mention that on this property we have a narrow strip of plantation running up the slopes of the hill to between 800 and 900 feet above sea level. It is very narrow towards the upper end—about 40 yards wide—and, seen at a distance, resembles bare poles against the sky line, with a faint streak of green at the head of them. Yet these poles, so the shepherd reports, distinctly diminish the violence of the wind. At Clifton-on-Bowmont, at an elevation of about 600 feet, I have been surprised to find the sheltering effect of firs, and other trees, in a plantation about 30 yards wide, and which is merely a collection of tall poles with some branches at the top of each tree.

With the aid of the new grass and deep-rooting plant mixtures I have suggested, stock can be kept in the fields much later than they can be at present, and as the old forms of shelter (ditches and banks, with trees on the top, and hedges, all affording much shelter) have to a large extent been removed, or allowed to decline, fresh forms of shelter are most urgently required. So strongly, indeed, is the desire for shelter that on this property, a great many years ago, a tenant agreed to pay, and did pay, my predecessor the interest on the cost of making four blocks of plantation for the centres of as many exposed fields. Plantations, too, are the more urgently needed for protecting the game, and especially the nests, which were formerly well protected by the

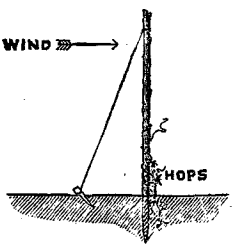
* After a three years' trial I find that we have had most satisfactory results from this shelter. It alters the character of the wind entirely, and does away with those fierce, rotary, gusts, which whirl plants round. The value is proved by the growth of the plantation, which is most satisfactory, and its site is on one of those windy passages in the hills which are swept by the severest blasts.

hedgerows and banks. Each plantation should have a grass margin within the fence of about 15 to 20 feet, and this should be planted with occasional bushes, and sown with seeds of the tall grasses, so that birds could be provided with comparatively safe nesting quarters. At present it is customary to plant close up to the boundary fences, and when the trees grow up the plantation is then of little or no use for nesting purposes. I now proceed to give the remarks that have been sent to me from Kent.

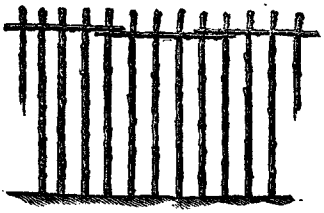
HOP SHELTERS OR "LEWS" IN EAST KENT.

These are now generally made by planting the Black Italian poplar in rows along the outside of the gardens, principally on the W., S., and S.W. sides, about three feet apart, and brushing up both sides of the row close in every year, in the winter and spring. These plants are easily raised by putting in the ground the shoots that are cut off; they grow very fast, and are allowed to get up about 18 or 20 feet. A row of Austrian pines planted not too close together, and a row of poplars a little way off, make a splendid "lew," but takes up a good bit of ground.

How far these "lews" will act depends on the conformation of the ground. If it slopes *up* away from the trees, of course they will not shelter the crop so far away as they would if the ground sloped down away from the trees, or even if it were level. On quite level ground, I should say they would be useful for 100 yards. Of late years a very coarse kind of cloth has been made, and sold cheaply, of cocoanut fibre; this is fastened to stout poles about 18 or 20 feet long, and about as big round as small scaffold poles. It is put up in the summer, and taken down in the winter, the poles being let into the ground, and supported by a wire from the top to the ground.

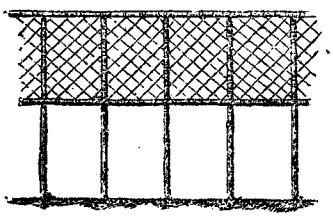


Sometimes we see a "lew" made by putting poles in the ground as close together as possible on the windward side of the garden, with a cross piece near the top just to keep the tops the right distance apart; this is bound on by cocoanut string or wire. This does not make a very good "lew" by itself, but is useful for stopping up gaps in a live "lew."

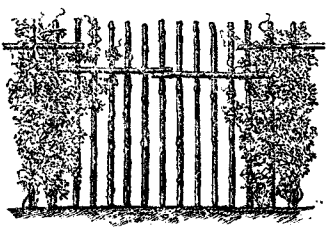


These poles would be the ordinary hop poles from 14 to 16 feet long, and about 9 or 10 inches round above the ground. They would be put in about 18 inches.

Sometimes the cocoanut lewing is fastened to these hop poles; for hops very often it is not put within five feet of the ground.



The poplar "lews" are by far the best; they grow very fast, and, if brushed in close every year, they get very thick with young shoots, which have large and tough leaves.



STOPPING GAP IN A LIVE "LEW."

APPENDIX VI.

Notes of the Stock kept at Clifton-on-Bowmont Farm. By the Factor.

Before the farm was taken in hand by the proprietor in 1887, it had carried a half-bred stock (Leicester-Cheviot cross), but from the then poverty-stricken state of the holding, and the want of grass in the arable fields, it was thought advisable to stock the outer or higher land with Cheviots, restricting the half-breds to the lower land, with the view of making the farm as much as possible self-supporting, in the way of turnips for ewes in the winter and spring months. This system of stocking was carried on for 15 years (1887-1902).

In view of a considerable portion of the arable land being laid down to grass, a change in the system was made in 1902, the half-breds which during the period above-mentioned had formed the stock on the lower portion of the farm, were sold and replaced by Cheviots, so that from 1902 the whole breeding stock of the farm has been Cheviots.

As some controversy has arisen, and as opinions differ as to which of these systems is the best to adopt on such a farm as Clifton-on-Bowmont, particulars of the management of both systems are here given, and the reader may thus figure out the results for himself.

PERIOD 1887—1902.

Management of Cheviot Stock on the Outer Portion of the Farm.

The stock were in five ages, viz.: ewe-hoggs, gimmers, 1 crop, 2 crop, and 3 crop ewes. The 1, 2, and 3 crop ewes were put to the Leicester tup, and the gimmers to the Cheviot. During

winter the ewes received no artificial feeding, but in the event of a snowstorm or hard frost a daily allowance of hay was supplied. From time to time during the winter any lean ewes were drawn out and received a little extra treatment. Previous to lambing the ewes got turnips for about four weeks, being either folded on them for a few hours daily, and run off to grass afterwards, or the turnips were cut and laid down on the grass land. The ewe-hoggs were grass-wintered on the hill, supplemented with a daily allowance of ¼ to ½ lb. of mixed cotton cake and dried grains, and for a month in the spring they received, in addition, a cart load of cut turnips per day, per hundred. The ewes bringing half-bred lambs received no artificial food after lambing time.

In the month of August the lambs were weaned, the half-bred wedder and cheviot wedder lambs being marketed, and as many of the half-bred ewe lambs as were fit for breeding, were retained to keep up the half-bred stock on the lower part of the farm. In the same way as many as possible of the Cheviot ewe lambs from the gimmer age were kept for stock purposes. The draft age (5 years) were sold in September.

Management of the Half-bred Stock.

This stock, as previously mentioned, was confined to the lower part of the farm, and was in four ages, viz.: ewe-hoggs, gimmers, 1 and 2 crop ewes; the gimmers and the 1 and 2 crop ewes being all put to the half-bred tup. The fields and lower portion of the hill ground, supplemented with a daily allowance of ½ lb. cotton cake, generally kept the ewes until about the month of January, when they received a further allowance of a cart load of turnips per day per hundred. About the end of February the cake was discontinued and the turnips gradually increased from this to lambing time (April 1st). The ewes were folded on turnips during the day and run off to grass land at night. Turnips were laid down to the ewes during lambing time and until the lambs were a fortnight old, when they received no artificial feeding of any kind.

The half-bred ewe hoggs were wintered on turnips, at the rate of a cart load per day per hundred, with a daily allowance of ½ lb. mixed cotton cake and dried grains, and as much cut hay

and straw as they could eat. During August and September the whole of the half-bred ewe and wedder lambs were marketed, as also the draft age of ewes.

In order to keep up the stock under this system it was necessary to buy each year a number of Cheviot ewe lambs, as the number of ewe lambs available from the gimmer age was insufficient. These, together with the Leicester half-bred and Cheviot tups required, were all the sheep stock it was necessary to buy each year.

The Present System.

As before mentioned the whole of the breeding stock is now Cheviots. These are in four ages and are drafted as five year olds. The 3 and 2 crop, together with a proportion of the one crop ewes, are mated with a Leicester tup; the remainder of the 1 crop ewes and the gimmers being put to the Cheviot tup.

During winter the ewes and gimmers are treated alike, and (with the exception of any ewes showing signs of getting lean, which are drafted out from time to time) receive no artificial feeding except during a snowstorm or severe frost, when a daily allowance of hay is supplied to them.

About the end of February or beginning of March, the ewes have a few turnips laid down to them on the grass land, at the rate of a cart load per day, per hundred. This is continued for about 10 days, when the ewes are folded on turnips during the day, and run off to grass land at night until the time of lambing (April 1st).

The ewes bringing half-bred lambs are allowed turnips during lambing time, but those in lamb to the Cheviot tup, are lambed on the hill ground without any extra feeding. The Cheviot ewe hoggs are wintered in the same way as the same class of stock under the previous system. The marketing of the half-bred wedder lambs is begun early in August and is followed by the half-bred ewe lambs. These being first cross command a high price for breeding purposes. The Cheviot wedder lambs and also the draft age of ewes are sold in September. Under this system a few Cheviot ewe lambs are bought each year to keep up the stock. These and the necessary Leicester and Cheviot tups constitute the only other purchases.

Cattle.—During the first twelve years very little breeding of cattle was carried on. The necessary number of cattle for breaking down the straw was bought during October in each year and wintered on straw and cotton cake. A portion of them was sold in the spring following, and the remainder was grazed and sold in the autumn. As the profit under this system was uncertain and very variable, it was decided to make the farm self-supporting in the way of cattle, by breeding what was required. A start was made by retaining some of the heifer calves from the best shorthorn dairy cows, from the Home Farm, and these along with a few pedigree shorthorn cows which were purchased formed the foundation of the present herd. The cows are all put to a pedigree shorthorn bull. The heifers are served to calve at 2 years old, and suckle their calves, as three and four year olds. They suckle two calves each and are generally drafted as five year olds, being served so as to calve early in the year in which they are drafted. The calves are weaned in November, and are wintered on a few turnips and some hay, with a daily allowance of linseed-cake and crushed oats. In May the steers are sold, as also any heifers not required for stock purposes. The bull calves from the pedigree cows are brought out for sale and sold at the annual bull sales in spring.

Horses.—None are bred on the farm as the stony nature of the ground is unfavourable to the proper development of the foot of the young horse.

Pigs.—A few sows of the large white breed are kept and their produce sold at about eight weeks old.

In the writer's opinion, a half-bred stock on the lower land, with a Cheviot stock on the outer portion of the farm, is the system which will pay most rent, and there seems no reason why the fertility of the land should not be as well maintained under this system of stocking, as it would be were it under a stock consisting entirely of Cheviots.

ROTATION OF CROPS ON CLIFTON-ON-BOWMONT FARM.

The following is a record of the cropping on Clifton-on-Bowmont Farm for the last twenty years :—

Alghope Field, North Section, 15 acres.

1890. Grass (Sown 1884)	1895. Oats	1899-1905. Grass
1891. Turnips	1896. Rape	1906. Rape
1892. Oats and Seeds	1897. Turnips	1907. Oats
1893-4. Grass	1898. Oats and Seeds	

Alghope Field, Middle Section, 15 acres.

1890-6. Grass (Sown 1884)	1898. Oats and Seeds
1897. Rape	1899-1907. Grass

Alghope Field, South Section, 10 acres.

1890-1907. Grass (Sown 1884).

Alghope Field, South top corner, 1 acre.

1890-1903. Grass (Sown 1884)
1904. Rape, Buckwheat and Seeds
1905-7. Grass

Bank Field, 27 acres.

1890. Grass (Sown 1888)	1894-6. Grass	1900. Barley and Seeds*
1891. Oats	1897. Turnips	1901. Hay
1892. Turnips	1898. Oats and Barley	1902-7. Grass
1893. Barley and Seeds	1899. Turnips	

* The Mixture of Seeds sown in 1900 was the now celebrated "Bank field" Mixture.

Big Countridge Field, 22 acres.

1890. Turnips	1895. Turnips	1899. Hay
1891. Oats and Seeds	1896. Oats	1900-6. Grass
1892. Hay	1897. Turnips	1907. Turnips
1893-4. Grass	1898. Oats and Seeds	

Big Haugh Field, 29 acres.

1890-1. Grass (Sown 1886)	1894. Hay	1903. Turnips
	1895-1900 Grass	1904. Oats and Seeds
1892. Turnips	1901. Turnips	1905. Hay
1893. Oats and Seeds	1902. Oats	1906-7. Grass

Bowmont-side Field, 16 acres.

1887. Barley and Seeds
1888. Hay
1889-1892. Grass
1893. Oats
1894. Turnips
1895. Barley
1896. Turnips
1897. Barley and Seeds
1898. Hay
1899-1900. Grass
1901. Turnips
1902. Oats
1903. Turnips
1904. Oats and Seeds
1905. Grass
1906 Hay
1907. Grass

Bowmont-side Field, Top Section, 5 acres.

1887. Barley and Seeds
1888. Hay
1889-1907. Grass

Chapel Croft Field, 14 acres.

1890. Turnips
1891. Oats and Trefoil
1892. Grass
1893. Turnips
1894. Barley and Seeds
1895. Hay
1896-7. Grass
1898. Turnips
1899. Oats
1900. Turnips
1901. Barley and Seeds
1902. Hay
1903-4. Grass
1905. Hay
1906. Turnips
1907. Oats

East Countridge Field, 15 acres.

1890. Turnips
1891. Oats and Seeds
1892-3. Grass
1894. Turnips
1895. Oats and Seeds
1896-1903. Grass
1904. Turnips
1905. Oats
1906. Turnips
1907. Oats and Seeds

Front Field, 21 acres.

1887. Barley and Seeds
1888-1892. Grass
1893. Oats
1894. Turnips
1895. Barley
1896. Turnips
1897. Oats and Seeds
1898-1904. Grass
1905. Turnips
1906. Barley and Seeds
1907. Hay

Harewells Field, 19 acres.

1890-1. Grass (Sown 1888)
1892. Oats
1893. Turnips
1894. Oats and Seeds
1895-9. Grass
1900. Turnips
1901. Oats
1902. Turnips
1903. Oats and Seeds
1904. Hay
1905-7. Grass

Hayhope Shank Field, East Side, 18 acres.

1887. Turnips
1888. Barley and Seeds
1889-92. Grass
1893. Turnips
1894. Oats.
1895. Turnips
1896. Oats and Seeds
1897-1900. Grass
1901. Oats
1902. Turnips
1903. Barley
1904. Turnips
1905. Oats and Seeds
1906. Hay
1907. Grass

Hayhope Shank Field, West Side, 23 acres.

1887. Turnips
1888. Barley and Seeds
1889. Hay
1890-92. Grass
1893. Turnips
1894. Oats
1895. Turnips
1896. Oats and Seeds
1897. Hay
1898-9. Grass
1900. Oats
1901. Turnips
1902. Barley and Seeds
1903. Hay
1904-7. Grass

Inner Kaimrig Field, 25 acres.

1890. Oats and Seeds
1891-3. Grass
1894. Turnips
1895. Oats and Seeds
1896. Hay
1897-9. Grass
1900. Turnips
1901. Oats
1902. Turnips
1903. Oats and Seeds
1904-7. Grass

Little Countridge Field, 10 acres.

1890. Barley and Seeds
1891. Hay
1892-4. Grass
1895. Turnips
1896. Oats
1897. Turnips
1898. Oats and Seeds
1899-1903. Grass
1904. Hay
1905. Oats
1906. Turnips
1907. Oats and Seeds

Little Countridge, Island Field, 3 acres.

1890. Barley and Seeds
1891. Hay
1892-1903. Grass
1904. Hay
1905. Oats
1906. Turnips
1907. Potatoes and Cabbage

Little Haugh Field, 15 acres.

1890. Oats
1891. Turnips
1892. Barley and Seeds
1893. Hay
1894. Turnips
1895. Oats
1896. Turnips
1897. Oats
1898. Turnips
1899. Barley and Seeds
1900. Hay
1901-6. Grass
1907. Hay

Outer Kaimrig Field, 23 acres.

1890. Oats and Seeds
1891-5. Grass
1896. Turnips
1897. Oats
1898. Turnips
1899. Oats and Seeds
1900-2. Grass
1903. Hay
1904. Grass
1905. Turnips
1906. Oats
1907. Barley

Shereburgh Field, East Side, 18 acres.

1897. Grass (Sown 1875)
1898. Turnips
1899. Oats
1900. Turnips
1901. Oats and Seeds
1902-7. Grass

Shereburgh Field, West Side, 15 acres.

1897. Grass (Sown 1875)
1898. Oats
1899. Turnips
1900. Oats and Seeds
1901-7. Grass

Woodhill Field, 24 acres.

1890. Oats
1891. Turnips
1892. Oats and Seeds
1893-8. Grass
1899. Turnips
1900. Oats
1901. Turnips
1902. Oats and Seeds
1903-5. Grass
1906. Oats
1907. Turnips

APPENDIX VII.

The following letter has been received from a tenant farmer, who has practised the Clifton Park system. The description of his method of taking turnips after lea will be found most valuable :—

" Dear Mr. Elliot,

" I have much pleasure in giving you a few of my opinions as to what I have learned from your Clifton-on-Bowmont experiments, and the truths contained in your book, 'Agricultural Changes.' From my own experience of the Clifton methods of rotation and seeding carried out during the last few years, I can speak with absolute certainty, and I am perfectly satisfied that much of the poorer land in the south of Scotland could be immensely improved by changes in the system of cropping such as you suggest. One only needs to consider the saving of manure bills, and the increase of crops by at least 20 to 40 per cent. both of grain and roots grown from land that has been rested in good grass, and good grass means good live stock and more of it. It also means a less labour bill, or rather a better paying labour bill. It also means, and this is no small consideration, cleaner land, freer from weeds and couch—so prevalent in the old four and five course rotations—and thistles in particular, as this pest can only be eradicated by successive cultivation of the soil over a course of years, a fact patent to all visitors to Clifton-on-Bowmont. Four years ago I selected one of my best fields for experiment on Clifton lines, and I am pleased to say with extraordinary results. My first turnip crop, taken after good grass which had lain four years, produced over 30 tons per acre. A crop of Banner oats following thrashed out at 80 bushels per acre. The succeeding swede crop of 1906, on which the East of Scotland College Manure and Variety tests were made—and a very indifferent turnip season at that—averaged

a little over 29 tons. The last crop of the rotation has now (1907) been reaped, viz., barley, which is by far the best crop of that grain on the farm. The field is now sown down with selected seeds of the best quality to lie in grass four, or more years. Now, 'facts are chiels that winna ding,' and it goes without saying that the excellent results obtained from the said field would also hold good on other fields and other farms.

"I have often received enquiries as to the difficulty of taking turnips after old lea, and I admit that there are difficulties on certain soils, and under certain conditions, but I am convinced from my own experience that on moderately deep soils, heavy or light, there is, on the contrary, an immense saving of labour. My method is to plough early in November, if possible, using a wheeled plough fitted with the long Scotch type of mould and skim coulter. With such a plough a few inches of the grass rim is neatly turned into the bottom of the furrow forming a cushion which keeps the land dry, and open to the frost, at the same time thoroughly rotting what would otherwise be half-growing turf if ploughed in the ordinary way. The preparation of such land in the spring for the turnip crop is of the simplest and easiest possible, nothing more being required than a double run with the harrows or a run through with the cultivator, taking care not to disturb the buried turf, which by the month of May will be in a perfectly decomposed or rotted condition to feed the growing plants. The single operation of drilling up lightly with a ridging plough completes the operation, leaving the very finest seed bed possible, so necessary for a good braird of turnips. I have grown turnips year after year in that way and on all kinds of soil, and have never experienced the slightest difficulty, and invariably the crop has equalled if not surpassed the stubble break heavily dunged and manured and costing double the amount for labour. Now, sir, in a country such as this, where the breeding and feeding of sheep is so successfully carried on, and which is by far the best paying live stock on the farm, and likely to continue so for years to come, I think many farmers who raise and feed sheep will agree with me, that a good crop of turnips produced from the lea break on the above or any other method, is of immensely more value than a crop of oats, taking one year with another. I am sure you have proved conclusively by the object lesson of Clifton-

on-Bowmont, that considerable changes in our system of cropping and seeding would be of immense advantage on most of the land in the south of Scotland at present starved for the want of better grasses, clover sick, and crop sick for the want of change. Everything must change, and, however well our old rotations have worked in the past under different conditions, I thoroughly agree with you that the time has come when new methods must be adopted. Science teaches us how to maintain the fertility of the soil, not by artificial manuring, but from Nature's own laboratory, free nitrogen from the air by the aid of deep-rooted plants and clovers. Let us take the best means, and every means to assist nature, and in the end she will prove no niggard in her gifts. I have not attempted to cover half the ground I might do in giving my experience of farming and crop growing by different methods. If you have any further enquiries to make in reference to the same I will only be too pleased to give you my experience.

"I remain, yours respectfully,

"(Signed) W. R. MURRAY."

Charterhouse, Kelso, N.B.
28*th October*, 1907.

Our system at Clifton-on-Bowmont is to plough the field first of all in the ordinary way, and afterwards to plough it diagonally. The field is afterwards harrowed, and the turf is then found to be divided into such small pieces that there is no difficulty in preparing the land for turnips. Mr. Murray's system is not suited to our Clifton-on-Bowmont farm, the soil of which is of uneven depth.—R. H. E.

THE OPINION OF A WELL-KNOWN BORDER AGRICULTURIST ABOUT THE FARMING AND STOCKING OF CLIFTON-ON-BOWMONT FARM.

Linton Bankhead, Kelso,
25th September, 1907.

Dear Sir,

In answer to yours of the 10th inst., regarding the farming and stocking of Clifton-on-Bowmont, I would like to say at the outset that I have had great pleasure in going there several times a year for the past 19 years, and that I have not only admired the success of your various experiments with new grasses, but have also so much appreciated the same that I have adopted many of them for our regular five course rotation, and find great benefit from doing so.

Now, as to farming and stocking Clifton-on-Bowmont, as a tenant, I would assume it to carry about 45 score of ewes with their hoggs (but number does not matter much as my arguments will apply in the same proportions to smaller numbers). I should still have kept at least 3 pairs of horses, and made from 50 to 60 acres of turnips every year, either from lea, old grass, or from oat stubble; thus, every year getting young grass from the crop sown with seeds after turnips, so very valuable for ewes and twin lambs. I look on Clifton-on-Bowmont as one of those farms that can be almost self-sustaining as regards stocking, and this leads me to that part of the subject. Now, assuming 45 score ewes, I should have divided them into 30 score half-breds and 15 score Cheviots, keeping the Cheviots on the west side of the farm and the half-breds on Shereburgh and Sunnyside, taking half-bred lambs of the Cheviot ewes of older ages if kept to five years old, and Cheviot lambs of the gimmers and young ewes, thus breeding on the farm ewe lambs to keep up the half-bred stock, possibly needing to replenish the Cheviot ewe stock by buying first-class Cheviot ewe lambs to make up what may be short. Then the half-bred ewes would have mated with half-bred rams, and being very careful in selecting the truest type of half-bred ewe lambs from the ewes and gimmers which I was sure were out of Cheviot ewes, so as not to get too far away from Cheviot blood, for hardiness, and nursing mothers. Thus, with

50 to 60 acres of turnips, and a fair, liberal allowance of other feeding stuffs at certain seasons to both ewes and hoggs, all the lambs and drafts for sale could, I think, be easily brought out in good condition. Also, having 100 acres or thereby of crop would have maintained a goodly number of best stirks, letting them run out during the day most of the winter, bringing them out for sale in early spring, the best of them in good condition ready to finish off on grass, and either sell the smaller and thinner sorts, or graze and sell them in autumn, buying in younger cattle then, according to crop and prospects of keep.

There is no need for me to go into detail as to what fields to crop because you have so much scope to select whatever the man on the spot in any given season should think would be most suitable, and I would not bind him down even to take a white crop after turnips in every year, as on some of the outlying land a crop of turnips eaten on the ground and then sown out with a suitable mixture of grasses, of which you are an acknowledged expert, might very well be the most profitable.

Such would have been my lines of farming when you entered, and I do not think that, for another period of 15 to 20 years, it would need much, if any, variation.

We cannot get good sheep for fattening purposes—half-bred, three-quarter-bred, Oxford, or any other cross—without their mothers having a certain amount of turnips for their health's sake; and to keep up a good standard of half-bred ewes is for all this district the keystone of our business, so far as has yet been found out.

Hoping that I have answered your queries as desired,

I am,

Yours faithfully,

W. G. Hogarth.

Robert H. Elliot, Esq.,
Clifton Park, Kelso, N. B.

APPENDIX VIII.

SUGGESTED CHANGES OF FARMING SYSTEM.

READ AT A MEETING OF THE BORDER UNION AGRICULTURAL SOCIETY AT KELSO, OCTOBER 31, 1902—THE RIGHT HON. THE EARL OF DALKEITH, M.P., IN THE CHAIR.

Before beginning my lecture this afternoon I will, with your permission, make a few remarks on part of the speech which my friend, Mr. C. J. Cunningham, made the other day at the Yetholm Show Dinner. The gist of his remarks on agriculture in Scotland were that it is deteriorating, and I have heard the same remark made by many others—two of them farmers of great experience. At first sight their opinions would appear to be ill-founded, for in these days we have much better agricultural machines of all kinds, better horses, and certainly better stock than we had, say, fifty years ago, and all the operations of agriculture are carried on as well, or better than they were. Where, then, does the alleged deterioration come in? It comes in, I am sorry to say, from a most serious cause—the gradual deterioration of the soil in all these cases where the land cannot be fed with such large supplies of farmyard manure that the humus can be adequately maintained. What proportion of the soils of Scotland have been thus harried out owing to the decline of their vegetable matter it is impossible to say, but that the proportion of land that either cannot be supplied at all with farmyard manure, or is only supplied with very insufficient quantities, is very large, there can be no doubt. It is in order to endeavour to remedy this serious defect in our agriculture that I have asked you to listen to the following remarks; but, before proceeding, it may be as well to note exactly how it was that so much of the land has thus been run out. It was so owing to the introduction and injudicious use of artificial manures. Previous to their introduction the farmer relied on farmyard manures, and the accumulation of humus, by leaving the land long in grass; but, when artificial manures came in, he could give the plants a sufficient stimulus to grow a large root system, which could not otherwise have been grown, and this root growth enabled the plant to exhaust the land. Artificial manures, if backed by farmyard manure or turf, may often be of the greatest value, by affording a stimulus at a critical period

of the plant's growth. Without these aids, or ample supplies of humus, in some form, the stimulated plants must deplete the soil,

As we are living in changing times, the members of this Society will probably agree with me in thinking that it is very desirable that we should occasionally meet in order to interchange opinions and mutually communicate our experiences. You will observe that I have proposed for our consideration the changes necessary in our farming system, and I have done so because it is becoming every day more clear that farming on the old lines is unsuited to the times, and because circumstances are gradually becoming more and more unfavourable to it. Here, for instance, is one important difficulty to which, so far as I am aware, no attention has as yet been called—the fact that, as compared with twenty years ago, we have a shortage of no less than one and a half millions of children in Great Britain. This indicates a movement of great importance to farmers, and if the people of these islands are showing such an active desire not to propagate their species, it is high time that we should propagate our ideas as to the best way of working our farms with a smaller number of hands. For the present the anti-child producing movement seems to be confined to the towns and manufacturing centres, but it is sure to spread to the country; in the meanwhile there will, of course, be a much larger draft of population from the country districts, and consequently we must look forward to scarcer and dearer labour. With the other adverse conditions you are all familiar, and I need only say that all of them are, from whatever point of view we may regard the subject, unfavourable to the present farming system. What that is we all know—expensive tillage, the use of purchased foods and manures, and a rapid rotation of crops, calling for much expense and labour, and entailing much exhaustion of the soil. When prices were high they could cover the cost of production and leave a good profit, but not so, of course, when prices fell; and we must recognise the fact that high farming on the present lines is no remedy for low prices, and the further fact that the only remedy available is to lower the cost of production. This may be effected, as I shall show, by an alteration of system, which will lead not only to the utmost economy of production, but render all production more free from risk than it is at present. The whole of my experiments at Clifton-on-Bowmont have been devoted to these ends, and I am now satisfied that whereas the old farming system gave us good crops at a high cost, we can, with the aid of improved farming, produce as good, and often much better, crops at less cost, and certainly with far less risk from adverse seasons. With it we can not only repair the exhaustion of the soil, caused by our farming system, but continually increase its fertility, and while this can be

done our expenditure can be largely reduced. These views are fully set out in my "Agricultural Changes and Laying Down Land to Grass." I am told that many farmers would adopt my system, either wholly or in part, but that they are deterred from doing so by the cost of the mixtures I have most recently used. One of my objects in addressing you to-day is to show how a farmer may most cheaply, and at the same time effectively, modify his farming system so as to bring it into line with the conditions of these times.

If the farmer has his land in fine physical condition, and, from applications of farmyard manure, well supplied with humus, there is no reason why he should not at once use the expensive Bank field mixture; but if his land is in poor condition he should, I think, use the appended mixture for the first rotation, as he would then avoid the risk of putting down an expensive mixture with the soil in poor condition. I began my farming at Clifton-on-Bowmont in 1887 with the following mixture:—

	lbs.		lbs.
Cocksfoot	16	Perennial Red Clover	2
Perennial Ryegrass	4	White Clover	4
Hard Fescue	2	Alsike	3

At a cost of £1 2s. 5d. per acre:

my object being to fill the land with vegetable matter at the smallest expense. This was used for the Front and Bowmontside fields, and the results have proved very satisfactory. In consequence of the steep stony nature of the land 4 acres of the latter field were left in permanent pasture, and, as such, have always done well. Where timothy suits the soil and climate it may be added to the mixture, and the cocksfoot may be lessened. The quantity of clover now seems to me to be excessive, and in recent years I have never used more than alsike 1 lb., white clover 2 lbs., and late-flowering red clover 2 lbs., a quantity which may still further be reduced, as I have obtained excellent results with a total of 3 lbs. of clovers per acre. The mixture I would now recommend as the cheapest to be advised, and which is suitable for two or a greater number of years, and is also fairly well suited to permanent pasture, is as follows:—

	lbs.		lbs.
Cocksfoot	14	Late-flowering Red Clover	2
Hard Fescue*	2	White Clover	2
Rough-stalked Meadow Grass	1	Chicory	3
Alsike Clover	1		

* It has been suggested to me by Mr. Hunter of Chester, that up to 700 feet meadow fescue would be more suitable than hard fescue, but it should be remembered that the latter is a much more drought-resisting grass.

Where the land is suitable for timothy 3 lbs. of it may be added, and the cocksfoot reduced to 12 lbs. I may add that in recent years, in consequence of the greatly-increased use of the grasses and plants recommended by me, they have much gone up in price, the Bank field mixture in 1890 costing £1 19s. 5d., while it cost last year £2 2s. 6d., and this year £2 9s. 10d.; but I am informed, on good authority, that prices will again fall when the attention of seed growers is directed to the subject.

When the natural grasses are used alone, or with but a very small quantity of ryegrass, it is important to note that the clover never fails, even though there may be an almost universal failure of clover in cases where ryegrass alone is used, or with only a small quantity of natural grasses; and though the Clifton farm was in poor condition when I took it in hand, we have never had anything but complete success in growing clover, and have had excellent results in the case of land that was only limed once, when it was taken out of the hill about forty-two years ago, and has never been manured or limed since. It is important to dwell carefully on the great value o clover and its only too common failure, which is by far the weakest point in our farming, while it ought to be, and can be, made the strongest point of all, from a manurial and physical point of view.

The principle of the rotation of crops is the alternation of crops which take nitrogen from the air with those which can only derive it from the soil—speaking generally, the alternation of the Leguminosæ (of which beans, vetches, and clover are commonly used here) and cereals. I this can be carried out annually, land may be cropped for thousands o years with the addition of hardly any manure. In Mysore six drills of a cereal crop are sown with a seventh of beans (*Dolichos sricatus*). After harvest the spaces between the drills of beans are ploughed up, and the crop (somewhat like a French bean) soon almost covers the ground, and is harvested in due course. The straw of the crops is eaten by cattle, and their manure is used as fuel, the ashes only being returned to the land, the decaying roots of the beans, and the atmospheric nitrogen collected by them, being the sole manures besides the scanty supply of ashes; and yet, with the aid of these resources, every year you will see a crop of corn and a crop of beans more or less good, according to the season. In our agriculture clover is, generally speaking, the nitrogen-collecting crop, but it only occurs once in four or five years, and, should the crop fail, the land must wait four or five years for another. Now the failure, or partial failure, of the clover crop means much more than the loss of most valuable food, for it means as well the loss of vegetable matter, and the atmospheric nitrogen which would otherwise have been collected through the agency of the nodules on the clover roots. The loss from the latter alone may often be estimated at about 10s. an acre. By the farming system adopted at Clifton-on-

Bowmont, and the rejection of ryegrass, these losses can with certainty be averted.

The next weak point in the present system lies in the fact that from the use of the shallow-rooting ryegrass, and the absence of deep-rooting plants which can not only aerate, but deeply till and manure the soil, the farmer not only fails to take advantage of the natural resources at his disposal, but fails to take advantage of the stores of plant food which lie at depths below the reach of the plants he now uses. In consequence of the downward filtration of manure, it has been found that the unused subsoil is often richer than the upper soil, which alone is used by the farmer.

The third weak point in the present farming system is that when a serious drought occurs the farmer is completely at the mercy of the season. In the case of last year's drought, when there was such a general failure of grass, and especially of clover, the Bank field on my farm had a most luxuriant appearance all the season through, and the results clearly prove that, with the aid of the new farming system, the farmer may regard the worst drought with absolute indifference. The facts are of such importance that I may quote the following passage from my letter published in the *Scotsman*, November, 1901 :—

"The Bank field consists of 27 acres, rather more than half of which is poor, stony, and exposed, and in some parts very steep land. The remainder consists of fair medium soil for that part of the country. For the last nineteen years 24 acres of the field have never been manured, excepting with the artificials used with the turnips. The remaining 3 acres have once—some years ago—had some farm-yard manure, and the seed mixture used, and the reasons for using it, are given on page 95 (2nd edition) of my "Agricultural Changes." It was sown last year with a crop of barley. From October 1st, 1900, to October 1st, 1901, the value of grazing and hay obtained was estimated by us at £7 3s. an acre. Our estimate has been referred to a tenant farmer, who is employed as a valuator, and his estimate comes to rather more—£7 7s. 6d. an acre."

From October 2nd, 1901, to October 1st, 1902, the field has been stocked as follows, and I purposely allowed it to be so much later in the autumn and winter than was judicious in order to see how the new mixture would stand the roughest treatment; and the effect of this, as might have been anticipated, has been a decline of the clover, though this seems to be recovering, and there is now an abundant feed of grass in the field, which is still stocked with 60 ewes. The list of the stock is as follows:—

From October 1st, 1901, to December 31st, 1901, 4 ewes per acre, with the assistance of one cartload of either cabbages or turnips per day for the field.

From March 15th to May 24th, 1902, 3 ewes and single lambs per acre, with the assistance of two cartloads of turnips per day for the field.

From May 24th to July 28th, 1902, 2½ ewes and single lambs per acre.

From July 28th to October 1st, 1902, 3 ewes per acre.

From May 1st, 1902, to June 10th, 5 cattle.

From June 13th to September 4th, 2 horses.

The fourth weak point of the existing system is that the farmer is put to considerable expense in weeding his fields. I found from an estimate made for me by one of my tenants that he was spending 11s. 4d. per acre in cleaning a field preparatory to sowing turnips. With our system of farming we practically have no weeds, or so few that they are not worth removing. In two instances we abandoned our usual system, and took oats instead of turnips out of grass, when, of course, weeds naturally followed. It may be mentioned here that our system is turnips out of grass, then oats, then turnips, when the land is laid down to grass, with oats or barley, and kept in grass not less than four years.

The fifth weak point of the present farming system is the great cost of handling and re-handling farmyard manure. With the new farming system you grow your manure on the spot in the shape of a deeply-rooted turf, which most fully supplies that humus which is the most valuable part of farmyard manure. This may now be carted direct from the steading, and scattered on the nearest grass field. By the careful investigation of the late Dr. Voelcker, it has been proved that this would involve no loss of manure (much of which is liable to loss on the existing system), though if left in small heaps on the land there would be a loss.

The sixth weak point in the present farming system consists of growing the most innutritious grass. I this year sent a sample of the Bank field hay to a friend, who obtained a practical opinion for me from a farmer who grows hay for the Liverpool market, and the sample, I may add, was by no means a favourable one, as all the best part of the hay had been used. The farmer writes as follows:—"I only regret I have not a thousand tons of such fodder, as I should then fear neither rent day nor pay day, nor, for the matter of that, scarcely any other days; such hay as I have before me would sell like wildfire in Liverpool, even in the face of severe home and foreign competition." It is interesting to observe how the opinion of the practical hay grower coincides with the analyses in Sinclair's work. The nutritive value of perennial ryegrass stands at 70, that of cocksfoot 80, tall oat grass 120, tall fescue 94, rough-stalked meadow grass 80, burnet 100, yarrow 98—all of these being grown in the Bank field mixture. Chicory stands at 60, or nearly the same

nutritive value as white clover. Sinclair gives no analysis of the kidney vetch. According to Dr. Stebler, in his "The Best Forage Plants," the proportion of nutritive matter contained in kidney vetch is greater than in red clover hay of medium quality. After enumerating thirteen grasses as being those which contain the most nutritive matter, Sinclair observes that "perennial ryegrass ranks with those that contain the least." It is not uninteresting to note that the opinions of the practical hay farmer, the analyst, and the horses all agree—the last so decidedly that they prefer the Bank field hay to oats—*i.e.*, they will leave the latter to eat the former.

The seventh weak point of the present farming system is that, in consequence of the absence of vegetable matter in the soil, the waste on all slopes is serious, and the downward waste of manurial matters is also very considerable. When the land is well stored with decaying turf the waste is entirely averted, and the downward percolation of the water is attended with no loss, or only a trifling one of nitrogen, as it is retained by the humus.

The eighth weak point in the present farming system is the exhaustion it entails on the soil, and of this I have heard frequent mention for many years past, besides having a large personal experience in the matter. Perhaps the most decisive evidence on the point is contained in the resolutions passed at the first great meeting of 400 Aberdeenshire farmers at the beginning of the bad times, when they attributed their difficulties to dear labour, bad seasons, and the exhaustion of the soil. The last statement proves what must now be evident to everyone, and that is that the present farming is a system not for maintaining and improving, but for continuously lessening, the fertility of the soil. But though the soil has been thus exhausted from a practical point of view, it has not been so from a chemical point of view. It has only been exhausted of its vegetable matter. Speaking generally of most soils, a sufficiency of mineral constituents are still there to last for the crops of a great many years, but these remain inert in consequence of the exhaustion of the humus; and perhaps the most valuable and encouraging point connected with my experiments at Clifton-on-Bowmont lies in the fact that it has been clearly proved that old worn-out lands that have been cropped for sixty or seventy years, and never manured, will produce as good, and even better, crops than they ever did if only you replace the vegetable matter which these soils contained when first enclosed from the hill. Misfortunes are proverbially said never to come single, and I may here notice that just as prices fell the Scotch farmer found himself tilling soils more exhausted than they ever had been, owing, as I have shown, to a system of agriculture which certainly tends to a yearly-increasing

decline of fertility, unless, of course, in those cases where a full supply of humus is kept up.

It may be useful to sum up some of the results you will certainly obtain from the new proposed system of farming. While your seedsman's bill per annum need not be increased, and may even be lessened, your gains from atmospheric nitrogen will be large and certain. The land will be more easily, and therefore more cheaply, ploughed and worked, while your tillage (by the agency of roots) will be deepened and improved; your weeding bills will be abolished, the success of your clover and grass will be certain, your artificial manure bills may be largely reduced; the supply of humus—in other words, the fertility of the land—instead of decreasing as it has hitherto done, will steadily increase (in some instances, we have trebled the value of the land); the expense of handling and rehandling farmyard manure will be saved. All crops will be healthier and better. The health of the stock will be much improved, and, as grass is the cheapest food for stock, more luxuriant pastures will entail less cost in feeding. Lastly, by rejecting ryegrass, you will be discarding a comparatively innutritious grass, and one that suffers much from drought, and leaves little vegetable matter, in favour of the grasses used in the Bank field mixture. Such, then, are the certain results you will obtain from the proposed farming system. As regards finger-and-toe, I cannot speak so confidently. I will only go so far as to say that I have reason to think that, with the aid of healthy conditions of soil, and especially an abundant supply of humus, and interposing, as we do at Clifton-on-Bowmont, a longer period between the last turnip crop of one rotation and the first of another, the risk from diseased turnips will certainly be largely diminished. Though we had some turnip disease in part of a field eight or nine years ago, we have had none since, even though last year there were many complaints of it in the neighbourhood; and in that year we had a good crop of turnips on land which had only been limed once, about forty-two years ago, and it had never been manured since, excepting with the artificials put down with the turnips; but the land was well supplied with humus, and had lain in grass for a number of years. Should, then, my surmises be correct, we should be able, with the aid of the new farming system, to save the great expense that is often incurred in liming as a temporary preventive or cure for finger-and-toe.

I now propose to remark on the various values to be derived from humus, or decaying vegetable matter, in the soil, in order to show the great advantage of the proposed system of farming in providing, through the agency of a solid and deeply-rooting turf, the largest quantity of this valuable agent. Humus is that substance which gives value to forest soils, or newly broken-up pasture lands. It is

at once a manurial agent, and a maintainer of the physical condition of the soil; but perhaps most valuable of all for its effect in conserving that moisture which is often of more importance to the plant than the presence of any quantity of chemical manurial constituents. It is, indeed, the very life and soul of the soil, and that is why the farmer, the planter, or the gardener attaches so much importance to farmyard manure, forest topsoil, turf, or any substance which will supply this indispensable ingredient of fertile soils. These humus-supplying agents all have this immediate advantage—the fact that the results from them are certain, while the results from all purchased manures are uncertain. For the latter may be washed away, or enter into insoluble compounds in the soils, and in the event of a drought the anticipated results might not be gained. The experience in the United States seems to be that it never can certainly be predicted whether profit or loss will result from the purchase and the application of nitrogen, potash, or phosphoric acid in any form. One thing is certain, says Roberts, in his "The Fertility of the Land" (Macmillan & Co., price 5s.), and that is that the application of farmyard manure, in almost any form, will result in improved fertility and increased profits. But this arises not from its, strictly speaking, chemical constituents, which could, of course, be supplied by chemical manures, but from the fertility which the decaying vegetable matter of the straw imparts to the soil, the most important feature of which is probably owing to the power of humus for conserving moisture, seeing that plants more often fail from lack of moisture, at a critical period of their growth, than from dearth of chemical constituents of plant food; and it is of equal importance to note that as all the moisture in the soil may be needed, and often is needed in the growing season, it is most advisable to store, through humus, all that can be kept in the land. In three years' experiments with farmyard manure (Roberts, p. 148), it was found that the first surface foot contained 18¾ tons more water per acre than adjacent and similar but unmanured land, the second 9·28 tons, and the third 6·38, or a total difference in the first 3 feet of soil of 34·41 tons per acre. If, then, the Bank field was quite unaffected by last year's drought, it was mainly because the land was well stored with ploughed-down turf, and was therefore capable of retaining a full supply of moisture, though the land had not been manured with farmyard manure for the last nineteen years. But there was another important reason to which I would desire to draw particular attention—the fact that the land was thickly-shaded with plants, as it is from the want of this complete shading that the land suffers so much more in a drought than it need. For every vacant patch of soil is really a pump, as the moisture, rising from below, is rapidly evaporated and carried away by the wind, and water is also drawn into each patch by lateral

attraction, to be, of course, at once evaporated. Each patch, then, though only as big as half-a-crown, starves all the adjacent plants, and as these plants are commonly thinly planted in the land, and consist of the shallow-rooting ryegrass, it can easily be understood why my field, well supplied with humus, and thickly shaded with plants, many of them of deep-rooting character, remained luxuriantly green while those of my neighbours were dried up.

Let me now briefly enumerate the other effects of humus. It not only supplies nitrogen, but, as it decomposes, renders available some of the phosphoric acid and potash of the soil. By keeping the soil more open it aerates the land, and so sets free more plant food. It enables the soil to retain manurial matter which would otherwise leach away. This is particularly the case with ammonia, and it has been found that a soil destitute of humus will contain scarcely any nitrogen. The importance of humus to light soils is enormous, as they are much less retentive of manure than heavy soils. By keeping the land open humus enables superfluous water to drain through the soil, and by keeping it more open prevents it being soured. Air, moisture, and warmth, which are all so necessary for the germination of seeds and the growth of plants, are but little influenced by the chemical constituents of the soil, being all more dependent on its physical condition, which can only be effectively influenced by large quantities of humus, which, I may observe, can, by us, be most cheaply supplied by deeply-rooted turf. It is important to notice that, as a consequence of growing a deeply-rooted turf, you can deepen the soil above and add to it below. In the case of the Inner Kaimrig field, enclosed from the hill about seventy years ago and never manured since, the ploughing depth had sunk to about 6 inches. It is now about 9 inches, 2 inches being gained above from the admixture of turf with the soil, and 1 below from the action of the deep-rooting plants, and this depth can certainly be added to as time advances. When growing a good deeply-rooted turf, then, you will not only be supplying much more and much better food for stock, but you will derive from it, when ploughing up, a long train of most valuable consequential results, which will at once favourably influence anything you may subsequently grow, and ensure that the utmost economy of production is arrived at. Perhaps one of the most important results is that, through the agency of deeply-rooted plants, and those with a large root system, you can, and at no additional cost, most minutely and deeply till the soil. The amelioration of the soil from root action is indeed most marked, and our attention has been frequently called to it, and more especially in the case of the Outer Kaimrig. When we ploughed our first turf the work was of such difficulty that, in my "Agricultural Changes," I suggested that it might be better to begin the rotation with rape, in order that time might be given for the decay of the turf; but the

amelioration of the soil is now so great that there was no difficulty experienced in breaking up the turf for the second rotation. It is only, I may repeat, with the first turf that there is any difficulty in taking turnips out of grass. Such, then, are some of the results to be obtained from humus, and the use and action of deeply-rooted plants and grasses, and I think I have said enough to recommend the subject to your earnest attention, for it is only through the adoption of agencies like these that we can hope to place our agriculture on a satisfactory footing.

My lecture is ended now. I am confident that the general principles I have recommended are sound, and I say so after the perusal of much public criticism on my work and opinions, and hearing many private opinions of value, and after having, since my "Agricultural Changes" was published, carefully studied the works of the American agricultural writers. But though I am confident that the general principles I have recommended are sound, it by no means follows that any cut and dried particular method of carrying them out can possibly be laid down. Each man must be left to carry them out in whatever way is suitable to the climate, and general condition of his farm and circumstances; and I will go so far as to say that not only does every farm require the principles to be worked out in a different way, but that every field on the same farm may require variations in the method of carrying out the principles of the proposed farming system.

One word more: Insist on your seed being guaranteed as to purity, germination, and weight per bushel. See personally to the mixing and sowing of the seed, and that it is sown as soon as possible after being mixed. In the spring take a rake, and re-seed with your own hands, as I have done, every vacant patch in the field, and you will then see how well, or how ill, your work has been done. In this connection I should advise farmers never to cease urging the Government to establish a central seed-testing station, where farmers could, for a small fee, get their seeds tested. This was recommended in the report of the Committee of 1900 appointed by the Board of Agriculture, but no steps appear to have been taken in the matter. This neglect of the interest of the farmers seems the more astonishing, seeing that the advantages of such an establishment have been amply proved by the Swiss Government. There is much need also for an Act to enforce that seedsmen should guarantee the purity and weight per bushel of their seeds, and that the guarantee should be stated on each invoice, as in the case when fertilizers and feeding stuffs are sold.

APPENDIX IX.

THE CLOVER MYSTERY: A PROBABLE SOLUTION OF IT.

READ AT THE MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT CAMBRIDGE, AUGUST 19th, 1904.

JUDGING from my own observation, and the opinions of the numerous visitors to my Clifton-on-Bowmont experimental and demonstration farm, this subject is of increasing importance. "No one," said a visitor lately, "can be certain that if he sows Clover he will be sure to get a crop of it." "If you can only solve the Clover difficulty," said another, "you would be of the greatest service to agriculture." "This crop of Clover," said a third, looking at a crop growing on the poorest field on the farm and keeping four ewes and their twins per acre, "is worth going 200 miles to see." What a deplorable condition must our agriculture be in if such things can be said of that nitrogen-collecting crop on which the success of the subsequent crops and grazing so largely depends. The following experiment and the explanation of its results, throw much light on the subject. One of my agricultural visitors laid down with one of my mixtures (without rye-grass) two halves of a field with seed bought from our respective seedsmen. In both cases the production and appearance of the Clover after the harvest was the same. By the spring following the Clover supplied by his seedsman had vanished, while that supplied by mine continued to flourish. Being anxious to compare the Red Clover supplied to me with that supplied to my agricultural visitor by his seedsman, I asked a neighbour of the experimenter to take home some of my Clover plants (grown from seed supplied by my seedsman), but he was unable to make the comparison as not a single plant from the seed which had failed could be found. Had the whole field been sown with seed supplied by my agricultural visitor's seedsman, there would, of course, have been no Clover at all, and the farmer and his friends would have said, "Oh, Clover sickness again," and thought no more about the matter, such disappearances being quite common and invariably accounted for by that supposed malady. On referring the experiment to my seedsman and asking him to explain why my Clover (supplied to me by him on a large scale for upwards of 20 years past) has always succeeded, while that of my neighbours has often been a partial, and not unfrequently a complete failure, he has replied as follows:—

"As regards the unfailing success of your Clover crop, I think this is, in the first place, due to your deep cultivation, by deep rooting plants, and, in the second place, to the use of seed of a good and hardy strain, and that has been grown in a suitable climate. How much is relatively due to the system, and how much to the seed, it is impossible to say; but you have abundantly proved that the two together have resulted in unfailing success. The Red Clover you have used at Clifton-on-Bowmont has been the late-flowering red variety, which is exclusively grown in England, chiefly on the Cotswold Hills, and the quantity of seed raised annually bears a very small proportion to the quantity of Red Clover annually sown in Great Britain. But there are other varieties of Red Clover, grown in England and other countries, which are very desirable, such as ordinary English red, Canadian, Russian, North of France, etc.—hardy sorts of large growth—and if these strains of the best quality were exclusively used in this country, and grown on your system, I do not doubt that the Clover crops of the United Kingdom would be as invariably successful as are the crops at Clifton-on-Bowmont."

The failure then of the experimenter above mentioned to grow Clover from the seed obtained from his seedsman was evidently owing to the latter having supplied seed grown in the South of France, Italy, the United States, or some comparatively warm climate, and I think it is perfectly clear when a crop of Clover comes up in a thoroughly satisfactory manner in the autumn, as that of the above mentioned experimenter did, and totally perishes by the spring following, the failure can only be attributed to the seed having been produced in some much warmer climate than ours.

Let us now turn to the cases where the failures are partial, or, in other words, where the crop falls far short of what it might and should be. In this connection the experiments and results at Clifton-on-Bowmont conclusively support the value of deep-rooting plants and grasses and the system of farming adopted, which is fully described in my "Agricultural Changes and Laying down Land to Grass."

On ploughing down the first turf in my system of rotation a great improvement in the Clover crop is perceptible, but a most marked improvement is shown, which cannot be estimated at less than 25 per cent., after ploughing down the second. The increase of Clover then rises in proportion as the land is filled with decaying vegetable matter and deeply tilled with the agency of roots which enable water to pass rapidly downwards and rise as freely, by capillary attraction, to supply the great demand of the Clover for moisture. There is then no difficulty in forming a decisive opinion as to one of the steps necessary for obtaining the fullest and most

certain success in growing Clover, and I say certain because we have succeeded equally well in growing good crops of Clover in seasons of the most severe drought as we have done in the most favourable seasons.

If the preceding arguments are sound, they lead to the certain conclusion that the use of a large proportion of Rye grass is adverse to growing Clover with the fullest degree of success, for it has been found by experiments made by the Highland and Agricultural Society that the amount of roots left by a mixture of natural grasses (other than Rye grass) and Clover is about twice that from Rye grass and Clover, and, I need hardly add, must be much greater in the case of the mixtures used by me. It must be considered further that as Rye grass is a rapid grower it deprives the Clover of food, and what is probably of more importance, moisture at a critical period of its growth. It is not then surprising to find that clover flourishes the better as the quantity of rye grass is diminished, and its place supplied by the other natural grasses.

There are then three things probably necessary if we wish to grow uniformly the fullest crops of clover no matter what the character of the season may be, namely, (1) seed of a hardy strain, and drawn from a suitable climatic source, (2) a farming system that will deeply till the land with the agency of deep-rooting plants, and store it with much humus, and, (3) the exclusion of perennial rye grass or its reduction to a small proportion of the mixture used.

Let us now consider the minor contributory causes of failure to grow the fullest crops of clover. These are (1) sowing an excess of clover seed; (2) injudiciously grazing in autumn and spring, more especially of course in the first 12 months; (3) cutting the covering crop so closely as at once to bleed the Clover and leave little shelter for the plants; (4) failing to roll the land judiciously in first autumn and spring, and especially before admitting stock; and, (5) raking the stubble and thus injuring the Clover plants. As a sixth minor cause I was at first inclined to add, "the too frequent repetition of Clover," but on further consideration I have doubts as to whether the usual repetition of the plant, though more frequent than in the case of my farming system, is at all hostile to growing fairly good crops where suitable seed has been in association with little or no perennial rye grass, for, though my system has undoubtedly largely increased the crops of Clover, we always had what farmers considered to be good crops of Clover, in the case of the four farms which have been on my hands, and of which I have had an aggregate experience of over 25 years, and also, with the exception of one field to be afterwards alluded to, in the case of a fifth farmed by my son, and I would call particular attention to the fact that this was the case when the farms were first taken over, and before of course my system (excepting the omission of Rye Grass) had had time to

influence the crops. But when I let the best of these first mentioned farms, the tenant had no difficulty in producing what is called Clover sickness, and that too more than once, and in a most marked degree on one of the best circumstanced fields on the farm. These facts certainly seem to lead to the conclusion, that if a farmer sows good seed produced in a suitable climate, and uses little or no Rye Grass, he may be sure of growing fair crops of clover, though he could not expect them to be nearly as good nor as uniformly good as he could obtain were the land cultivated on the Clifton-on-Bowmont system.

As the facts as regards the sole instance of failure seem of interest I give the manager's report of the field in full:—

"STACKYARD FIELD GRASS MIXTURE, ONE YEAR'S HAY."

	lbs.		lbs.
Italian Rye Grass - - -	10	Alsike Clover - - -	3
Cocksfoot - - - -	5	Kidney Vetch - - -	3
Late Flowering Red Clover	4		

"The seed was put in with a good mould with the exception of the heavy clay portions of the field, which at the time of seeding were somewhat rough. There was not a heavy crop of barley, and there was none of the crop 'lodged.'

"There was a fair take of seeds after the corn was cut, but a want of Clover, more especially on the clay portions. The 'seeds' were grazed in the late autumn with sheep, but only to a moderate extent. When the hay was cut (a fair crop) there was little Clover to be seen —none in the heavy clay parts—the same remark applies to the Kidney Vetch.

"It is sometimes said that 'Cocksfoot does not come the first year'—in this field Cocksfoot bulked largely in the hay crop."

It is, I think, of practical interest to add here that I have in my long planting and agricultural experience observed the same causes of soil decline both in India and in Roxburghshire, and have successfully adopted, in essentials, the same remedy in both cases. We (the planters) cleared forest lands on the Western Ghauts of Mysore and planted them with coffee. All went well till the stock of humus in the soil fell to a low ebb, when the inevitable decline ensued accompanied by decreased production, and increased plant diseases. We then consulted the agricultural chemists, who advised varying combinations of artificial manures, but this only made matters worse, leading to a bumper crop one year and hardly any crop the next, accompanied, as might be supposed, with a decline in the quality of the berry. Then I went back to nature and carted on to my land immense quantities of forest top soil, in other words soil rich in humus, and this entirely changed the aspect of affairs, as the land was thus restored in a very great degree to its virgin

condition. In like manner I have treated the once run out soil of the Clifton-on-Bowmont farm, where field after field had been enclosed from the hill. The virgin turf gave of course, with the aid of a little artificial manure with the turnips and swedes, splendid crops for a certain number of years, but as, from the distance from the steading, no farmyard manure could be applied, the inevitable exhaustion of humus ensued. There was only one way of remedying the evil, and that was to produce humus on the spot in the shape of turf. This was done with the aid of my system, and I have found by comparative analysis that I have not only restored the run-out humus, or decaying vegetable matter of the virgin turf, but supplied it in a much more effective degree, in consequence of my deepening the soil with the aid of the deep-rooting plants and grasses used in my mixture. Whether then the season is excessively wet or one of extreme drought, we produce without fail the fullest crops of clover, which, I need hardly add, are the indispensable base of all economical and successful agriculture where the Leguminosæ can be grown, and not only for the food supplied for stock, but for the physical and manurial effects provided for the use of the future crops of the rotation. To sum up.—If you can grow clover you can grow grass, and if you can grow grass you can, with the aid of deep-rooting and drought-resisting plants, grow in four years a turf which is manure for four crops without any added manure, either by feeding cake on the land or artificials, except perhaps a small quantity of the latter for the turnip and swede crops, and these I hope entirely to abolish next year, as I have found by experiments that after ploughing up a second turf none are required. Nor are they in the case of potatoes. On comparing my yield last year with that of the Balderston Farm experiments near Linlithgow, where 20 tons of dung and 7½ cwt. of artificials were used, I not only, with the aid of a good turf, beat the experiments as to amount of production, but showed a much larger profit, as I used neither dung nor artificials. In this connection it is important to note the following, as growing potatoes with the use of turf alone as manure seems to have an important effect not only as to production, but also as to superiority of eating-quality of the potatoes, and especially with reference to potato disease. The variety I used was the *Up-to-Date*, and it produced 13 tons 14 cwt. per acre and there were practically no diseased potatoes, only an occasional one such as, I am told, is commonly seen in all cases. In the case of the same variety the Balderston experiments gave 10 tons 18 cwt. 6 lbs., and no less than 7 cwt. 2 lbs. of diseased potatoes.

It is of practical interest to note the steps taken by our predecessors in Scotland to maintain the humus of the soil by dividing farms into infield and outfield, and guarding the latter from exhaustion, as the amount of farmyard manure available could of

course no more maintain the necessary amount of humus then than it can now. So far as I can judge from the leases of my property of 1782, the outfield was only to be ploughed once at the beginning of a lease, after which it was to lie three years in grass (or four years from sowing the seed, as in Scotland they do not count the first year). If ploughed again a certain course of cropping was prescribed, after which the land was to lie in grass till the end of the lease. When, however, artificial manures came in, such restrictions were abandoned, and field after field of the outfield was added to the infield till all was absorbed, and kept on a system which steadily exhausted the humus of the land. And this circumstance has of course been largely aggravated by the failure of the Clover crop—sometimes entire and sometimes partial, as we have seen—for is it not obvious, from what I have previously said, that the failure of the humus limits the Clover crop, and that, in turn, the failure of the latter limits the supply of the former? In this connection I may call attention to a letter over the signature of "Blue Book," which appeared in *The Times* of August 10th, which shows, by a reference to agricultural conditions and prices in France, that to provide cheap food you must have soil fertilized with humus the supply of which has been increased, through the medium of straw, by the high wheat tariff of 1892.

In conclusion I may point out that if, with the aid of a leguminous base, agriculture can be carried on for thousands of years with hardly any manure, our agriculture, aided as it is by the manure of animals, ought certainly to be able to do so without the aid of any purchased manures if the farmer can only make sure of growing large crops of Clover. In Mysore, the farmers sow 6 drills of a cereal crop to 1 drill of a bean crop, which in its early stages is suppressed by the former. After harvest the space between the bean drills is cultivated, and the crop—not unlike a French bean in appearance—soon spreads over the ground. The straw of the crops is used to feed cattle, and their manure is burnt for fuel, the ashes only being returned to the land. These crops are repeated annually, thus giving a scientific rotation (the alternation of crops which derive nitrogen from the atmosphere with those which must derive it from the soil) each year, and with the aid of the atmospheric nitrogen, the roots of the bean and cereal crop, and the ashes of the fuel, crops, more or less good according to the season, have been produced for many centuries, and will continue to be produced. The scientific rotation of the English farmer occurs only once in four or five years with his Clover crop, and if that fails he has then to purchase plant food which ought to have been produced in abundance on the land. On entering one of my fields of Clover which was of a beautiful dark green hue, an agricultural visitor observed to me "This field has been nitred."

"So it has," I replied, "but it has been so from the nitrogen produced on the land with the aid of my farming system." It may be observed that when the farmer buys nitrates, he only buys a chemical agent, whereas when he grows plants which yield him nitrogen he not only acquires plant food but a physical agent as well which ploughs the land with its roots, ameliorates the whole condition of the soil, and thus enables the plants successfully to contend with the vicissitudes of our climate and the diseases to which all plants are liable.

From what I have previously said it might be supposed that I think that the agricultural chemist is no longer needed. That is far from my idea, but the chemist must become more of a farmer, and the farmer more of a chemist before either can work effectively in arresting the downward course of our British soils. For upwards of 25 years I have now had them through my hands on a large scale, from alluvial flats up to elevations of about 800 feet, and of almost every kind. I have no reason to doubt that soils elsewhere are in much the same condition, and if they are I am sure that, with the present agricultural system, they must gradually be deteriorating, and that the exhaustion of the soil, so universally complained of by the farmer, must be more and more aggravated as time advances; the general conditions can only be improved by providing the means for growing large and uniformly successful crops of Clover, and if this can be done, as it has been by me on the stony, steep, poor, and exhausted lands on the slopes of the Cheviots, it could much more easily be done elsewhere. But an improved farming system leading to this end can only be generally attained within a reasonable period of time if the farmer is aided by the following conditions. These are (1) the diffusion of practical information on the subject by Government Experimental Stations, (2) the provision of government seed testing stations, (3) obliging seedsmen to pass an examination (just as druggists are) before being allowed to practise their business, (4) the guaranteeing by seedsmen of the rate of germination and purity of all seeds, (5) that agricultural chemists should have had a practical agricultural training before being allowed to practice, and (6) that the present system of conducting manurial experiments should be placed on a wider basis. To enlarge on all these points here would be impossible, but numbers 2 and 6 are of such immediate importance, and can be so readily taken up and acted on, that a few sentences may be devoted to their consideration. As to point 2, it may be briefly stated that with the exception of Great Britain all the leading countries of Europe have official seed-testing stations, where the utmost facilities are given for the testing of agricultural seeds. Even Ireland, thanks to the Hon. Sir Horace Plunkett, has such a station in Dublin. Such stations were advised for Great

Britain by the Departmental Committee which sat upon the subject in 1900, but the bewildering variety of our national affairs no doubt leaves little time for the Government to notice the needs of the biggest and most important industry in the kingdom. The sixth point requires notice at greater length.

The usual practice is to conduct manurial experiments on ordinary British soil, in other words soil that has been run out of humus, is therefore in bad physical and manurial condition, and which has not been cultivated nearly to the depth that it might and should be. Plot No. 1 of such land is marked "no manure," and to the other plots are applied various manures, and conclusions drawn therefrom. Now if we assume that the agriculturist can do nothing further by himself to fertilize the soil, over and above what he does at present, no further steps would be required, and in any case nothing is to be said against this system, so far as it goes, but from not being accompanied by similar manurial experiments on soil which has been tilled and fertilized to the utmost (as the Clifton-on-Bowmont soil has been) through the agency of natural means, the conclusions arrived at by the experimenter must always be incomplete. It is evident then that in every case where ordinary British soil is used for experimental purposes, soil of similar character should be raised to the level of the soil on the Clifton-on-Bowmont farm and then experimented on with artificial and other manures similar to those used for our ordinary run-out soils. A similar course should also be be pursued where grass lands are experimentally manured with the view of showing the effects of various manures in providing more and better food for the animals grazed on the pastures. In this way only could it be determined how far artificial and other purchased manures pay the farmer who chooses to use to the utmost, as I have, the resources which nature has placed at his disposal. My own experiments are too limited to enable me to pronounce a confident opinion, but, at present prices of farm produce, they lead to the conclusion that purchased fertilizers, though giving an increase of crop, do not pay after the land has been cultivated for a rotation on the system I have adopted. But should the prices of farm produce rise such manures would certainly be required, and after a considerable lapse of time it is probable that, even with my system, certain soil ingredients would become so deficient as to give rise to a demand for purchased fertilizers. Fully to determine those important points ought to be the aim of all who are interested in the progress of British agriculture, for cultivation on the old lines, leading to decreasing humus and increasing manure bills, is no more a remedy for low prices than one-sided free trade is for free imports, and it is only by arriving at the utmost safety and economy of production through the agency of natural resources used to the utmost, that our agriculture can be placed on a sound and enduring basis. When

this has been attained—when the land has been cheaply and deeply tilled and aerated with roots, and thus inter-penetrated with humus—the value of the chemist and the manure merchant will be most strikingly apparent, and will be as absolutely certain as, in consequence of the low state of fertility of our soils, the value of both is at present uncertain. If you apply artificial manures to a mineralized soil you may lose much of your money if the season is either over-wet or over-dry. If you apply them to soil amply supplied with humus the results from the manure are certain, as a fully humus-fed soil is able to set at defiance the vicissitudes of the season, and besides, ripens the crops earlier (last year my barley was got in in good condition, while that of my neighbours was caught by the rain), and from giving a good nidus for the plants, renders them less liable to disease.

I think I have now established the fact that the future success of our agriculture depends upon growing full crops of clover, and shown how this can be done with absolute certainty, and I may mention in conclusion that I have made a list (published in *The Farmer's Gazette*, Dublin, November 28th, 1903) of no less than twenty-six distinct consequential advantages which arise out of growing it with the aid of the system of farming adopted on my experimental and demonstration farm. This consists of putting down a mixture of three large grasses, one small one, three clovers, kidney vetch, chicory, burnet, and yarrow, which is left for four years, or more, if desirable, and is followed by turnips, oats, turnips, and barley or oats with grass seeds. With this system weeds are so completely abolished that none have been removed from the farm for the last 12 years, and visitors have said that they had never seen a cleaner farm. The effect on the health of the stock has been most marked, partly, I think, from the drainage caused by the deep-rooters, and partly from the tonic properties of the burnet and yarrow, and from the variety of food supplied. At a very large sale this year my half-bred ewe lambs topped the market, I obtained first prize for the tup lambs at the Border Union Show at Kelso, and it may be mentioned that, with the exception of some given to the 20 rams annually sold, no artificial food is used with the sheep stock on the 1,250 acres of which the farm consists. Do not the facts in this paper seem to show that on the whole the cheapest and best manure merchant is the seed merchant, and that he is also the cheapest cultivator and drainer of the soil, the most economical producer of meat, the best preserver of the health of stock, and the best promoter of their condition?

ROBERT H. ELLIOT.

Clifton Park, Kelso.

POSTSCRIPT TO PAPER READ AT THE MEETING OF THE BRITISH ASSOCIATION AT CAMBRIDGE, 1904:—

It may be advisable to note that my paper has been written from a practical farmer's point of view solely. His efforts should, I suggest, be directed mainly to methods for the most economical production of crops, and the prevention of the diseases to which both crops and animals are liable. The discovery of new manurial resources, the question of the application of chemical fertilizers, and the advisability, or inadvisability, of adopting curative methods for plant and animal diseases should be left to the scientific observer. As to the last named it is of importance to remember that when all the conditions are favourable to health the diseases of plants and animals exist as a rule to a comparatively small degree, and that they only do so to an injurious extent when circumstances are unfavourable. As regards the truth of this rudimentary fact I have had ample evidence both in the case of my Indian and Clifton-on-Bowmont experiences, where healthy conditions of soil, and general circumstances favourable to health, have shown most marked results as regards the diseases to which animals, plants, potatoes, and turnips are liable. It is of great importance, too, to remember that when, by preventive measures, the farmer spends money in such a way as to reduce losses from diseases, he is certain, as I have previously shown, to get a profitable and permanent return for his outlay, while the return from curative measures is always uncertain, and costly, and is generally of a temporary nature.

One word more. It is of practical interest to note that the farmers of the Eastern States of America are recruiting their run-out lands, not as farmers are being urged to do here, and are doing to a considerable extent, by purchased fertilizers, but by growing leguminous crops by which, at the smallest cost, the land can be both chemically, and, what is generally of more importance, physically fertilized, and much of the required nitrogen obtained from the atmosphere. In this connection a question of great importance in its immediate and consequential results arises. It is this. If the land by good farming can, with the aid of natural agencies solely, be fully supplied with nitrogen, why should the farmer purchase it? And if there is no need of his doing so why should the landlord have to pay, under the Unexhausted Manures Act, for any portion of nitrogen-yielding manures? It is a remarkable fact that the efforts made by the legislature, by means of costly experiments with artificial manures, and an act to protect the pur-

chasers of them, should tend, not to good, but to bad farming of a positively injurious form, to a greater and greater reliance on purchased fertilizers, which must always be uncertain in their action and often exhaustive to the soil, rather than to a reliance on that slowly decaying vegetable matter which must yield a certain profit to the farmer and steadily increase the fertility of the soil. And it is, if possible, still more remarkable that the Government should refuse to give compensation for nitrogen stored in the vegetable matter while it grants compensation for the unexhausted residues of artificial manures and cake fed to animals on the land.

It must be remembered that if the fertilizer bill can be cut down on some farms by the adoption of my system of farming this reduction will be more than made up to the manure merchant by the largely increased demand for artificials for the turnip crops of the land which will be again brought under cultivation when my system becomes general—land at present abandoned to worthless pasture, because it would not pay to cultivate it on the old farming system. When the system spreads more widely it seems to me clear that much down and more lands may be cultivated on the Clifton Park system.

It may be pointed out lastly that besides the required seed-testing station, and an act to compel seedsmen to guarantee the seeds they sell, an act is urgently required in order to keep spurious, diseased, and adulterated seeds out of the country. In America the Custom House officers take samples of all lots of seeds at the ports of arrival, and forward them to Washington for examination, and the seeds are at once allowed to pass on to their destination, but if the seeds are bad, or do not come up to a certain standard of quality, the names of buyer and seller are published, and thus public warning is given as to the holders of bad seeds. As farmers here are quite unprotected in this matter, spurious seeds, diseased seeds, and seeds mingled with weed seeds are imported without any restriction. It is hardly necessary to add that, unless farmers are aided in their work as the farmers in other civilised countries are, it will be hopeless to expect any rapid progress towards amending the present depressed agricultural situation.

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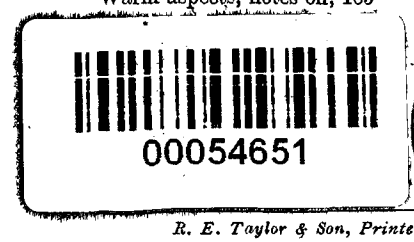

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